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ORIGINAL ARTICLES.

I.—Eminent Living Geologists: Rev. Osmond Fisher, M.A., F.G.S.

(WITH A PORTRAIT, PLATE III.)

THE subject of this notice belongs to a family of which several members have occupied high positions as clergymen and scholars. His father, the Ven. John Fisher, the early friend and patron of Constable, was Archdeacon of Berks, Canon of Salisbury, and Vicar of Osmington and Gillingham in Dorset; his grandfather, the Rev. Philip Fisher, D.D., was Master of the Charterhouse; and his great-uncle, the Rev. John Fisher, was preceptor to the Princess Charlotte, and subsequently Bishop, first of Exeter and afterwards of Salisbury.

Osmond Fisher was born at Osmington on November 17, 1817, and was named after the patron saint of his father's church. The district is an interesting one for geologists, and, while a mere child, Osmond used to accompany his uncle, the Rev. George Cookson, when collecting fossils in the neighbouring cliffs. At the age of 11 he was sent to Eton, where two years were spent under the fiery Dr. Keate without his receiving a single lesson in arithmetic. A year at home, spent in pursuing his natural bent for science, was followed by his removal to the house of his uncle, the Rev. W. Fisher, at Poulshot, in Wiltshire. Here he took up geology again, made out the structure of the neighbourhood (on the same horizon as Osmington), and collected fossils from the Coral Rag and other strata, some of which are now in the Woodwardian Museum. During the next two years he lived with his grandfather, the Master of the Charterhouse, and studied at King's College, London, where he began to read mathematics. He also heard one or two lectures from Lyell and Daniell, who were then Professors at the College, and roamed about the geological galleries of the British Museum.

In 1836 Fisher proceeded to Jesus College, Cambridge; and, though equally capable of taking a classical degree, fortunately decided on a mathematical career. After degrading a year on account of ill-health, he graduated as 18th wrangler in 1841. He was ordained deacon in 1844, and at once took the sole charge of his uncle Mr. Cookson's living at Writhlington, near Radstock, in the Somerset Coalfield, and was also elected a Fellow of his College.

In 1845 he was ordained priest, resided for a short time at Cambridge, and in the following year was appointed curate-in-charge of All Saints, Dorchester, where he lived for seven years. Here his leisure time was spent in geologizing along the Ridgway fault and in the neighbourhood generally. He frequently visited his uncle, Mr. Cookson, at Poorstock, near Bridport, and collected many fossils from the Inferior Oolite there, which are now in the Woodwardian and Dorset County Museums, the latter of which he assisted in founding. While he was at Dorchester the Geological Survey began mapping the district, and Mr. Fisher was able to give many hints to Mr. Bristow, who was in charge of the work. He also met A. C. Ramsay and E. Forbes when they came down to inspect its progress.

In 1853 Mr. Fisher became tutor of Jesus College, Cambridge. He had on previous occasions attended some of Sedgwick's lectures, and so made an acquaintance, which now ripened into friendship. Sedgwick had been his proposer when he was elected a Fellow of the Geological Society in 1852.

The busy life of a College tutor left little leisure for geology in term-time, but the vacations were still spent in Dorchester, where he worked hard at the Purbeck rocks. The results of his studies are contained in a paper read before the Cambridge Philosophical Society in 1854. The greater part of the collections he made at this time are now in the Woodwardian Museum, and include a series of fossil insects which have never yet been described. He afterwards took up the geology of the Bracklesham Beds, and gave the results of his investigations in a paper read before the Geological Society in 1862. The fossils then obtained are likewise to be found in the Woodwardian Museum.

In 1857 Mr. Fisher was presented by his College to the living of Elmstead, near Colchester, and was married to Maria Louisa, daughter of Mr. Hastings N. Middleton, then residing at Ilsington House, near Dorchester. While at Elmstead he spent a week with Henslow in Suffolk, and afterwards collected a little from the Crag and Pleistocene beds at Walton-on-the-Naze. In the absence of other more interesting subjects, he now turned his attention to denudation. His work on the 'trail,' which was done at this time, is perhaps one of the most important of his purely geological investigations. In 1867 he removed to Harlton Rectory, another College living, but shortly afterwards was left a widower, with five sons, all of whom are now living.[1]

Harlton is a quiet country village about six miles from Cambridge, far enough from railway-lines and main roads to acquire a certain sense of retirement, but close enough to a great centre of learning to stimulate thought and encourage original investigation. There are few villages in England so well known by name to geologists, many of whom have experienced the kindly hospitality of its present Rector.

[1] Some of the facts above given are, by the kind permission of the anonymous author, taken from an article in the *Cambridge Review*, March 16, 1893.

Mr. Fisher's removal to Harlton was almost concurrent with a change in the nature of his work. Pure geology was not, indeed, neglected, but it gradually gave place to the study of the great problems presented for solution by the earth's crust. The British Association met at Norwich in 1868, and Mr. Fisher was invited to open the proceedings of the Geological Section with a paper on the "Denudations of Norfolk." The coprolite deposits of the Cambridge Greensand and the mammaliferous deposits at Barrington also occupied a good deal of his attention, and form the subjects of papers read before the Geological Society in 1872 and 1879.

It is interesting to notice that Mr. Fisher, who is now the foremost opponent of the contraction theory, was many years ago one of its strongest advocates. He was, indeed, an independent discoverer of the theory. It occurred to him as early as 1841, the year in which he took his degree, and was suggested by the ridging up of cracked and re-frozen ice in one of the locks of the river Cam. In his delight at the discovery, he tells us, he forthwith vaulted over a five-barred gate. The idea, however, lay apparently dormant for many years; and it was not until April, 1868, that the first of his three well-known memoirs was read before the Cambridge Philosophical Society. At this time Mr. Fisher was orthodox in his views. He accepted the solidity of the earth's interior on the authority of Lord Kelvin as "almost certain," and considered that the outer crust would lose the support of the inner portions "probably from the effects of contraction in cooling."

When he is presented with a new theory, Mr. Fisher's first impulse is to test it numerically. The cause invoked may be a true one, but is it also sufficient? Is it capable of producing effects of the amount as well as of the kind observed? Here the mathematician steps in with advantage and offers useful aid to the geologist. In Mr. Fisher's first memoir the process is applied to the contraction theory. He shows that, if an outer spherical shell could be isolated from the mass within, it would at once be crushed by lateral pressure till it rested on that mass. The contraction theory thus invokes a true cause of rock-folding. To prove the sufficiency of the theory, he calculates roughly the order of magnitude which mountain-ranges, if so formed, might be expected to assume; and concludes that "the theory seems to be at any rate not deficient in its capability for producing the results attributed to it."

Five years later, in June, 1873, we find Mr. Fisher defending the contraction theory against Captain F. W. Hutton in the pages of this MAGAZINE; but, within a very few months, his allegiance to the theory must have begun to waver. The paper referred to contains the groundwork of his estimate of the mean height of the surface-elevations of the globe. He was then led to calculate more closely the mean height of the elevations that would be produced by the contraction of the earth in cooling; and his work is described in a second memoir read before the Cambridge Philosophical Society in December, 1873. The discrepancy is so great (more than 9000 feet in the one case, and less than 800 feet in the other) that Mr. Fisher

felt compelled to give up the contraction theory in its original form. Crust-folding he still attributed to lateral pressure brought into action by a shrinking interior, and he refers, though not with entire approval, to the view which he repeated in the first edition of his future work that the earth consists of a solid crust and nucleus with an intervening liquid layer.[1]

The third of the Cambridge memoirs, read in February, 1875, shows that his belief in such a constitution had gradually strengthened; for he investigates the form into which a uniformly thin flexible crust would be thrown if the support of the liquid substratum were from any cause withdrawn.

About this time, the direction of Mr. Fisher's inquiries was slightly changed. Mr. Mallet had shortly before published his well-known memoir dealing with the origin of volcanic energy. There is a fascination about the theory he advanced, but Mr. Fisher's quantitative analysis at once laid bare its weak point, though several months elapsed before the controversy was closed.

The evening of an active life can hardly be better employed than in revising the work of earlier years, and this is especially the case when that work has been devoted mainly to the solution of a connected series of problems. It can then be regarded almost as calmly as if it were another man's; there is ample time for considering criticisms without bias, for filling up gaps, and for exhibiting all the different portions in their true relations to one another. In 1880, at the age of 63, Mr. Fisher began the work with which his name will always be connected. The "Physics of the Earth's Crust" is, however, not merely a reprint or revision. It included, indeed, all those parts of his memoirs which seemed to him worthy of preservation, but the additional material forms a notable fraction of the whole. The book was published at the end of 1881, and in spite of its highly technical character, has from the very first met with a considerable sale.

Many a man, after so great a success, might have been content to rest upon his laurels. But Mr. Fisher seems to have regarded this first edition as a mere instalment, as a kind of guarantee that his work should not be wasted by sudden illness or death. During the years which followed he has not ceased to strengthen his theory, by building up fresh defences and by raids into the enemy's country. By 1889 a second edition had in his opinion become necessary (the remainder of the first being withdrawn from sale), and in 1891 this was supplemented by an appendix of three additional chapters.

Besides the papers incorporated in the "Physics of the Earth's Crust," Mr. Fisher has written many others, which have appeared in different scientific journals. The last of the series was published only seven months ago in the Philosophical Magazine, and deals with the residual effect of a former Glacial epoch upon underground temperature.

The Geological Society, always so ready to welcome the contributions of mathematical geologists, awarded Mr. Fisher the balance of

[1] At present he regards the solidity or otherwise of the nucleus an open question.

the proceeds of the Lyell Fund in 1887, and the Murchison Medal in 1893. In 1878 he was appointed Honorary Fellow of King's College, London, and in 1893 Honorary Fellow of Jesus College, Cambridge. In 1895 his portrait was painted by Mr. Coney. A copy of the picture was subsequently made by Mrs. H. A. Morgan, and accepted by the Society of Jesus College, in the hall of which College it now hangs. The admirable photograph here reproduced was taken by Mr. R. H. Lord of Cambridge in 1898.

The "Physics of the Earth's Crust" with its appendix may be said to consist of two distinct parts, a destructive part and a constructive part. In the first Mr. Fisher is chiefly occupied by a criticism of the contraction theory from the point of view of its insufficiency to account for existing elevations. If his assumptions are all correct, there can be little doubt that he has proved his case, whether the interior be wholly solid or partly liquid, and whether the shrinking of the nucleus be due to loss of heat or loss of included steam by means of volcanic eruptions. Of the other and more valuable part, there is no need to insert any description here. Mr. Fisher has himself given an exhaustive summary in his concluding chapters for the benefit of non-mathematicians, and every good textbook of geology contains some account of it. On re-reading the book after the lapse of several years, the points which chiefly strike one are perhaps the wonderfully close agreement between the theory and the phenomena to be explained by it, and the ingenious manner in which the physical objections to the existence of a liquid substratum are encountered.

It is impossible at the present time to make any estimate of the permanent value of Mr. Fisher's work. There can be no doubt that it is more highly appreciated in foreign countries than it is in England; for Mr. Fisher's views are generally regarded as unorthodox here, while abroad the balance is probably in their favour.

It is unfortunate that English opinion as to the condition of the earth's interior should be mainly led by a few mathematicians whose chief interests lie elsewhere. No controversialist is bound, or can be bound, to examine every criticism of his work, but so long as careful and conscientious criticisms are left unanswered, the judgment of others with regard to that work must be held in suspense. Mr. Fisher's investigations cannot be brushed aside as of little or no consequence. We may or may not believe in the practical solidity of the earth's interior; but, if we do consider this view as the more probable, we cannot but feel that the objections which he has offered require serious examination, and that our lines of communication for further advances are menaced until his attack is definitely repelled.

In reflecting on Mr. Fisher's work as a whole, one cannot help being struck by his self-sacrificing boldness. It is no light thing for a thoughtful man to spend the better part of thirty years' leisure in working out a theory the foundation of which *may* be swept away by some future discovery. In such a position many of us would guard our work with jealous watchfulness from all unfriendly glances. But at fourscore years and more, Mr. Fisher welcomes criticism; his

only complaint is that he cannot get enough of it. What he most of all desires, and what his patient labour deserves, is that his work should be subjected to a searching examination. But until his conclusions are proved to be wrong, we may fairly claim a wide toleration for whatever views on the physics of the earth's crust seem to us most nearly in accordance with the nature of geological phenomena.

Some time or other, no doubt, Mr. Fisher's chief life-work will be weighed in the balance. Whether it be found wanting or not, no one will dispute that he has solved one problem with complete success. However bitterly he may have been attacked, his courtesy has never failed. He is one of the few men whose part in controversy has enriched, and never degraded, science. He can look back upon a long life of fruitful labour and of kindly service to his fellow-men. At the same time he can reflect that he has never written a harsh word that he could now wish to be withdrawn.

C. Davison.

II.—New Fossil Bird and Fish Remains from the Middle Eocene of Wyoming.

By Charles R. Eastman, Cambridge, Mass.

(PLATE IV.)

THE Green River Shales of Wyoming have long been noted for their numerous and beautifully preserved fossil fishes. Fragmentary traces of bird-remains have been met with in the same horizon from time to time since the year 1869, when the first fossil feather reported from North America was obtained by Dr. F. V. Hayden.[1]

During the past summer the Museum of Comparative Zoology at Cambridge, Massachusetts, has come into possession of two remarkable specimens from the fish-bearing shales near Fossil, Wyoming. One of these is a gigantic Lepidosteid, of which only detached scales and vertebræ have hitherto been known; the other is a nearly perfect skeleton of a gallinaceous bird. It is the writer's intention to present a detailed description of both fossils at some future time, but meanwhile it is possible the following notes may be of interest.

Gallinuloides Wyomingensis, gen. et sp. nov. (Plate IV.)

Short-billed, stout-legged birds attaining the size of a gallinule, rail, or small coot, and resembling these forms in general characters. Coracoid straight and stout, without subclavicular process; furculum V-shaped, with well-developed hypocleidium. Wings short, bones of hind-limb of medium length. Femur one-fifth and tibia rather more than two-thirds longer than the tarso-metatarsus. The latter is flattened from back to front, has moderately expanded extremities, and a deep anterior channel occupying nearly the total length, which in the type measures 34 mm.; second trochlea slightly shorter than the fourth, and not produced towards the inner side. Lateral toes

[1] Amer. Journ. Sci. [3], vol. xi (1870), p. 272.

Gallinuloides Wyomingensis, gen. et sp. nov.

Middle Eocene : near Fossil, Wyoming.

subequal, about two-thirds as long as the middle one, and hallux one-third as long; middle digit and tarso-metatarsus of equal length. Plumage unknown.

The general appearance of this specimen is shown in the accompanying Plate, which is reproduced from a photograph without retouching. It will be seen that the body lies with its right side embedded in the matrix, the right hind-limb in advance of the left, the humeri elevated and overlying a bend in the neck. The right fore-wing is wanting, and the left is doubled over so as to expose the humerus from the palmar and the remaining wing-bones from the opposite or ventral aspect. The pelvis also is seen from the ventral side, the right hind-limb from in front, and the left partly from in front, partly from one side. Thus, one of the femora presents a lateral and the other an anterior view, but the coracoids and scapulæ are so turned as to exhibit mutually corresponding sides.

To speak of the imperfections first, the ribs are broken and confused, the caudal vertebræ are wanting, the dorsal displaced and in part scraped away by careless use of tools in the hands of a collector, and the cervicals in part concealed by the humeri. Between the scapulæ, and between the humeri and occiput, the vertebral column appears largely in section, owing to unfortunate mutilation. Most serious of all, however, is the damage done to the head, the bone-substance being so cut into or scraped away as to make it impossible to distinguish the separate elements. Depredations of this nature are wholly inexcusable, and cannot be too severely censured.

The *sternum* is well shown in lateral aspect, its body, however, being much compressed. The latter gives off a very long and slender intermediate xiphoid process, and a stouter and shorter external xiphoid, the distal extremities of both being expanded. The costal condyles for articulation with the sternal ribs are very small, and the costal process of only moderate proportions. There is a well-developed rostrum or manubrium, and the coracoid grooves are broad and deep. The coracoids themselves are relatively short and stout, without subclavicular processes and foramina; their sternal facets are considerably arched, and there is a faint hyosternal process. The clavicles form a narrow V-shaped arch, implying reduced powers of flight. The scapulæ are long and slender, with well-developed glenoidal and acromial processes, and are not distally expanded.

The bones of the *fore-limb* do not require special comment. The right humerus is seen in radial aspect, and shows a broad deltopectoral crest and prominent distal condyles. The latter are especially well displayed in the palmar view presented by the left humerus. Effects of pressure are apparent in the extreme width of the remaining wing-bones. It is possible, in addition, that the ulnæ of both wings are superimposed or are crushed contiguous to one another. Since the photograph was taken, all the limb-joints have been more fully exposed with the point of a needle.

The *pelvis* leaves much to be desired in the way of preservation. It presents the visceral aspect to view, the sacro-iliac roof being embedded in the rock; part of the sacrum is concealed by the overlying left femur. The anterior border of the ilium is convex; the post-acetabular portion is broader than the fore part, but of about equal length. The right acetabulum is distinctly shown, and measures 3·5 mm. in diameter. Just behind it lies the elongate-elliptical ischiadic foramen, and at the junction with the pubis is seen a very small obturator foramen. The pubes are long and delicate, slightly convex outward, and do not appear to have been attached to the ischia posteriorly. Only the first two caudal vertebræ are preserved. Concretionary structures are the cause of the discolorations in line with the distal extremities of the pubes, and adjacent to the left scapula.

The bones of the *hind-limb* are all more or less flattened by pressure. The femora are stout, nearly straight, and exhibit moderate-sized rotular channels and distal condyles. The left tibia is seen from the fibular side, with the fibula itself — together with the procnemial and ectocnemial processes — very much flattened. Of the distal condyles the inner is slightly the larger in fore-and-aft extent, the outer in transverse. An oblique bridge over the groove for the extensor tendons is faintly indicated close to the condyles. The tarso-metatarsus is flattened from front to back, traversed by a deep longitudinal groove along nearly the entire anterior face, has the external tibial facet on a lower level than the internal, and the second and fourth trochleæ of about equal size. The phalangeals of the first three toes are of about the same proportions as in the common pigeon, those of the fourth toe are longer. The proportions of principal parts are given in the subjoined table:—

Table of Measurements.

	Length in mm.		Length in mm.
Head	48	Manus	46
Scapula	48	Femur	42
Coracoid	27	Tibia	58
Furculum ...	33	Tarso-metatarsus	34
Crista sterni ...	58	I. Digit (7+4)	11
Humerus	47	II. ,, (11+8+6)	25
Ulna	49	III. ,, (12+10+8+6) ...	36
Radius	45	IV. ,, (7·5+5·5+4+4+?4)	25

Height of knee-joint (estimated) ... 90 mm.
Total height (estimated) ... ... 220 mm.

Six cervical vertebræ are discernible in section between the occiput and distal portion of the left humerus, the length of the series being 4·5 mm. Possibly six or seven more lie concealed beneath the humeri and glenoidal end of the right scapula. Measuring along the loop indicated by the position of the vertebral column gives a length of 85 mm. for the entire series of cervicals; the length of the dorsal series cannot be precisely estimated.

Relationships.—The characters outlined in the above cannot be brought into strict agreement with any one modern ornithic family,

but appear to be transitional between true gallinaceous birds and the group typified by coots, rails, and gallinules. With the last-named the present skeleton exhibits a number of features in common, and there is also some resemblance to curassows. An annectant type or a generalized organization is exactly what we should expect to find, considering the antiquity of the remains. For palæontological purposes, the limits of modern bird-divisions must be considerably extended, and this becomes the more imperative the further we recede in geologic history. Hence, in the present instance, we shall not be very far wrong in assigning to the new form a position intermediate between the orders Paludicolæ and Gallinæ, as these are commonly understood.

From the late Tertiary of America a number of representatives of the two last-named orders have been described by Cope,[1] Marsh,[2] and Shufeldt,[3] but so far as the writer is aware but one genus, and that a crane (*Aletornis*, Marsh), is known from the Eocene. The fragments described by Marsh as *Telmatornis priscus* and *T. affinis* from the Cretaceous marls of New Jersey are referred by him to the Rallidæ. *Rallus* itself and typical Gallinæ are first met with in the Upper Eocene of Europe.

Lepidosteus atrox, Leidy.

Only one of the eight 'species' of Lepidosteids described by Leidy, Cope, and Marsh, from the American Tertiary, is founded upon anything like a complete fish. This is *Lepidosteus cuneatus* (Cope), a small form about 30 cm. in length, from the Miocene of Central Utah. The remainder are established upon detached scales, jaw-fragments, and vertebræ, many of them too imperfect for generic determination. Our knowledge of European Lepidosteids is likewise confined to the same class of fragments. The fact is, fossil gars are very rare, and are known only from Eocene and Lower Miocene horizons.

Cope[4] observed that in French examples the maxillary is much less segmented than in recent gars; also that two of the American species (*L. atrox*, Leidy, and *L. glaber*, Marsh) have the "mandibular ramus without or with reduced fissure of the dental foramen, and without the groove continuous with it in *Lepidosteus*." Upon such slight differences he erected the new genus *Clastes*, to which all the American species are commonly referred. The complete specimen obtained this summer from Fossil, Wyoming, proves that a generic separation from *Lepidosteus* is impossible; the name *Clastes* therefore becomes a synonym, and it is further probable that the so-called *Clastes anax* of Cope is identical with Leidy's *L. atrox*.

The new specimen is beautifully preserved as a whole, the only serious defect being that the cranial bones are more or less crushed.

[1] Bull. U.S. Geol. Surv. Terr., vol. iv (1878), No. 2.

[2] Amer. Journ. Sci. [3], vol. ii (1871), p. 126; ibid., vol. iv (1872), pp. 256–8; Proc. Acad. Nat. Sci. Philad., 1870, p. 11.

[3] Journ. Acad. Nat. Sci. Philad., vol. ix (1892), pp. 411–416.

[4] "Tertiary Vertebrata," bk. i, p. 53 (Rept. U.S. Geol. Surv. Terr., vol. iii, 1884).

The tail and hinder part of the trunk present the right lateral aspect to view, but the remainder of the body lies squarely on the ventral surface and is flattened out symmetrically on both sides by pressure. The fins are superbly preserved, and with their bundles of finely articulated rays and fringe of biserial fulcra make a striking appearance. The total length of the fish is 1·7 m., of which the head forms about 0·5 m. In point of size, relative length of head, fin-structure, and squamation, there is a very close resemblance to the recent Alligator gar, or *L. viridis*, Günther; the dentition is much the same, and the number of longitudinal and transverse scale-series is the same in both. A detailed description of the new specimen will form the subject of a separate paper; it will be sufficient for the present to point out that the modern gar, and more particularly the Alligator gar, has existed from at least Eocene times essentially unchanged.

EXPLANATION OF PLATE IV.

Gallinuloides Wyomingensis, gen. et sp. nov. Middle Eocene: Fossil, Wyoming. *c*, coracoid; *cl*, furculum; *f*, right femur; *h*, *h'*, humeri of left and right wings respectively; *i*, ilium; *m*, manus; *p*, pubis; *r*, radius; *rb*, detached rib; *s*, scapula; *st*, sternum; *t*, tibia; *tm*, tarso-metatarsus; *u*, ulna; I–IV, toes.

III.—Some Snowdon Tarns.

By J. R. Dakyns, Esq.

I HAVE from my boyhood been intimately acquainted with Snowdon and its neighbourhood, and for some years past I have been investigating the geology of the district in a systematic manner. In doing this I have paid particular attention to the lake basins, and shall in the following pages give an account of some of my investigations as far as they have gone. I say as far as they have gone, because I hope in the future to make by means of a level more accurate measurements than can be made with a pocket aneroid; and I also hope that next Summer the lakes and tarns will be sounded either by myself or by someone else; for at present we know nothing about the depth of Llyn dur Arddu, next to nothing above that of Glaslyn, and very little about Llydaw, though that little is of great importance.

I will now proceed with my account. Glaslyn at its outlet is bounded by rock on the north side and by drift on the south, but the shape of the ground shows that the drift is merely a mound of no great thickness, banked against the Gribbin, as the rocky spur is called which separates Glaslyn from Llydaw. At a distance of about twenty yards from the lake solid rock is seen in the bed of the outflowing stream at less than six feet below the level of the lake. This to my mind proves without any reasonable doubt that the lake lies in a rock basin; for, as I said above, the drift is apparently of but little thickness, and the lake is certainly more than six feet deep: I have myself dived into it to a greater depth than that. I will not, however, insist upon this; for at the old mill, seventy yards from the lake, *solid rock extends right across the*

stream from the Gribbin on one side to the cliffy ground, on the other, along which the road from the mines runs. From this point in the stream one can ascend to the summit of Snowdon, either by the Gribbin on the south or by way of Crib y Ddysgl on the north, without treading on anything but solid rock. This point is, as measured by an aneroid, 40 feet below the level of the lake. Consequently, unless Glaslyn is less than 40 feet deep, it must lie in a rock basin, even if we neglect the fact that rock is seen in the stream at only a few feet below the level of the lake. We do not know the depth of Glaslyn, but it is probably more than 40 feet deep; for on the north side, near the mine, rock comes down to the water at a slope of 30°, and on the opposite side the average slope of the rocks coming down to the lake is even more than 30°.

I conclude, then, that Glaslyn occupies a rock basin. In their paper on the Lakes of Snowdon, Messrs. Marr and Adie write in reference to the outflow of Glaslyn, with all the emphasis of italics, "*the bottom of the drift-filled depression is at a lower level than the present stream*, which runs at the side of the valley, being separated from the lowest part by a low shelf of rock." What they call the present stream is an artificial watercourse made by the old miners to carry the surplus water of the lake clear of their works. Comment is needless.

Llyn Llydaw is dammed up by glacial deposits; but at 250 yards from the outlet solid rock is seen in the issuing stream and on both sides of it. This point in the stream is by my aneroid from 25 to 30 feet below the level of the lake. Mr. Watts, however, considers the first live rock seen by him in the stream to be 40 or 50 feet below the level of the lake. At 250 yards from the present outlet, in a N.N.W. direction, there is a depression by which the lake may possibly have once discharged itself; and at about 225 yards from the lake solid rock is seen in the bottom of this depression and on both sides thereof. According to the aneroid this point is 40 feet below the level of the lake. The space between the present outflowing stream and the above-mentioned channel is occupied by drift which thins away eastward, so that immediately south of the little pool, shown on the Ordnance six-inch map, rock forms the surface of the ground. The place where the rock is seen in the said depression, as stated above, is just where it is joined by another depression, which runs down from the little pool, and it is along this line that Mr. Marr imagines the lake to have formerly drained.

Consequently, in all possible outlets, real or imaginary, to Llydaw, solid rock is first met with in descending from the lake, at a level no lower than 40 or 50 feet below its surface. Llydaw must then lie in a rock basin unless it is less than 50 feet deep; but we have reason for believing that it is much deeper than 50 feet. Many years ago a man's clothes and boots were found lying beside the lake. It was supposed that the owner had been drowned. A professional diver was fetched up from Caernarvon, and search was made for the missing body. The late Henry Owen, the well-known

landlord of Pen y Gwryd, was present at the search; and he told a friend of mine that in one place no bottom was reached at the depth of 200 feet. Unless, then, this estimate was grossly erroneous Llydaw must lie in a rock basin.

There is not much to be said about Llyn dur Arddu. It lies at the head of Cwm Brwinog under the precipice called Clogwyn dur Arddu, which forms the south side of the Cwm, and rock is seen at the outlet on the south side of the stream; but no rock is to be seen on the north side of the lake, nor, as far as I know, for a long distance down-stream; in fact, on that side nothing is to be seen but a steep bank strewn with large blocks of stone, so that we cannot tell whether the tarn lies in a rock basin or not. Although nothing but the rock-strewn bank is to be seen on the north side of the Cwm, yet the unsophisticated intellect conceives that the Cwm is bounded on that side, too, by solid rock, hidden, however, by superficial detritus. There is absolutely no evidence to support the assertion of Messrs. Marr and Adie that the lake once drained more northward down a valley now buried under moraine. Not only is there no evidence in favour of such a view, but the chances are all the other way, for it presupposes a far greater thickness of drift than is known to occur in any part of the district. There are many places in the Snowdon region where the thickness of the glacial deposits can be measured. As far as I know, these deposits are thickest under Yr Aran, on the left bank of the Colwyn, about a mile above Pont Caer-gors, and here the thickness is less than a hundred feet. In most cases it is much less than this. Thus it is most improbable that there should be in Cwm Brwinog so great a thickness of drift, and that for the distance of a mile or more, as must be the case if there is such a buried valley as Messrs. Marr and Adie assume.

The tarns in Cwm Glas are so shallow that they are of little importance, but the lower one, Llyn Glas, most certainly lies in a rock basin, for, without going below the level of the tarn, one can walk all round it without ever treading on anything but solid rock.

I shall not at present say more about Cwm Glas, nor about Cwm Brwinog, as I hope on a future occasion to deal fully with the geology of these corries. Nor shall I now treat of the Snowdonian lakes as distinct from the tarns; but as Messrs. Marr and Adie, in the part of their paper on the Snowdon lakes dealing with Llyn Cwellyn, have indulged in some speculations and statements about a part of the country with which I am intimately acquainted, I must point out some mistakes into which they have fallen.

On p. 55 of their paper they say "a drift-filled depression is traceable up a tributary joining it" (the main stream) "a few yards south-east of Cwellyn State Quarry." This is a mere assertion: no proof is offered of the existence of drift in this depression; it is simply assumed, and in fact no proof can be offered, for along the course of the little valley there are no sections in superficial material save one near Ffridd quarry, where a pit has been dug for walling-stones in some loose stuff which may be morainic. Throughout the

rest of its course there is no evidence of the existence of glacial drift; but on the contrary some evidence that there is no drift in the depression, for solid rock is seen close to the stream at 100 yards north of the narrow-gauge railway; and still further north the valley is cumbered with large angular blocks consisting entirely of diabase, which have fallen from the cliffs above. There is no drift, for were there any we should find stones of many different sorts, and many of them would be rounded. So Mr. Marr's drift-filled gorge 350 feet deep is a mere figment of the imagination. I must also remark that judging from the shape of the ground Llyn Cwellyn is probably a great deal more than 50 feet deep.

As to the peaty watershed near Pitts Head, it matters nothing whether it is "composed of an alluvial deposit" or not, for the solid rock comes to the day in so many places that the superficial covering is evidently merely a thin skin.

On the next page the authors say "the bed of the Colwyn runs over drift until within a short distance of Beddgelert." I am sorry to be obliged to contradict the writers, but the above statement is incorrect. Neither the Colwyn nor its bed runs over drift immediately south of Pitts Head watershed, for solid rock is seen in the bed of the river at Pont Caer-gors and at several other places for more than 550 yards down-stream, at which distance the river actually runs in a rocky gorge. The eastern side of the Colwyn valley is formed of solid rock, not only throughout the whole of this distance, but for much further south. A low bank of drift forms the western margin of the river immediately south of Pont Caer-gors. This drift obviously lies as a tablecloth on a gently sloping surface of rock which comes to the day 300 yards west of the bridge. No drift-buried gorge is possible here. The upshot is that Messrs. Marr and Adie, in their hurry to escape from a rock basin, have invented an impossible gorge to carry the water of Llyn Cwellyn across a mountain range whose lowest point is 650 feet above the sea, that is, 186 feet above the present level of the lake. This is a brilliant effort of the imagination, though hardly of the scientific sort, but it does not come near that of the old Welsh, who imagined an underground connection between Llyn Cwellyn and the Llanberis lakes to account for the existence of char in both.

IV.—Note on a Crustacean *Mesodromilites Birleyi*, gen. et sp. nov., from the Gault of Folkestone, Kent.

By Henry Woodward, LL.D., F.R.S., F.G.S., etc.

ONE of the results incidental to the meeting of the British Association for the Advancement of Science at Dover in September last was a visit paid to Folkestone by the members of Section C (Geology). Among the ladies present was Miss Caroline Birley, well known both as a traveller and for the deep interest which she has always taken in palæontological research; she is also the owner of an excellent private museum of minerals and fossils,

mostly collected by herself. Miss Birley was fortunate in obtaining from Mr. J. Griffiths, the resident geological collector, a small but well-preserved carapace of a Gault Crustacean, believed at the moment to be the usual *Necrocarcinus Bechei* (Deslongsch., sp.), a form about as abundant in that locality as the *Palæocorystes Stokesii* (Mantell, sp.). The specimen, enlarged twice natural size, is clearly depicted in the accompanying illustration in the text.

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Mesodromilites Birleyi, gen. et sp. nov.

Gault: Folkestone. *a*, dorsal aspect; *b*, profile of same specimen. Drawn twice the natural size. The original specimen is in the possession of Miss Caroline Birley.

A more careful examination of the original convinced me that I was in error in referring this Crustacean to *N. Bechei*, or indeed to any species of *Necrocarcinus*; and after a lengthened search for an analogue I was compelled to believe it to be a new form, a thing well-nigh incredible in a formation like the Gault of Folkestone, which has been 'the happy hunting-ground' for so many generations of London and provincial geologists, and a spot dear to the name of J. Griffiths, who for the past fifty years or more has been the sole collector and geological guide of Folkestone Cliffs.

The figures give both the dorsal and lateral aspect of the carapace, and show it to be one-fourth longer than broad, very tumid in the centre, having three pairs of rounded sub-central tubercles (three on either side of a median dorsal line), with a central tubercle placed on the posterior metacardiac region. Two rather curved and elongated tubercles occur on the surface of the test outside the hindmost pair of sub-central tubercles and midway between them and the lateral margins of the carapace, just over the posterior branchial region. Five somewhat prominent tubercles

mark each lateral margin, the hindmost and most prominent pair being situated on a transverse V-shaped ridge and furrow, which cuts off the posterior fifth of the carapace, and meeting in the centre, where it is marked by the single median posterior tubercle already referred to.[1] The three succeeding pairs of marginal tubercles are about equal in size, and the front pair forms the outer angle of the orbital fossa. The rostrum is subdivided or notched in the centre, having a ⅄-shaped groove running down it, the base of which is directed forwards, and the diverging points reaching to the first pair of sub-central tubercles which mark the gastric region. The orbits are large and well defined. No nuchal furrow is visible. The carapace is not in the least crushed or distorted, and the surface is well preserved.

Differences and Affinities.—A careful comparison of our Brachyuran with the various species from the Gault and Greensand affords but little assistance in the specific determination of the specimen. In *Necrocarcinus*, when the rostrum is preserved it is not notched or bifurcated, but pointed in the centre; the median line of the carapace is not simple, but divided into distinct gastric and cardiac regions, and an anterior nuchal furrow can be traced; the carapace is broader than long; the marginal tubercles are not prominent, and the posterior or metabranchial furrow is absent.

Turning to *Dromilites* from the London Clay, one is at once struck by many points of resemblance. The carapace (as in our Gault fossil) is longer than broad, is very tumid, the rostrum is bifurcated, there is a median furrow, the tubercles are arranged in pairs; four pairs of marginal tubercles are present, the posterior metabranchial furrow is also seen; the orbits are large and conspicuous.

Unfortunately the other ventral aspect of the carapace is wanting in the Gault fossil.

Prof. Bell ("Fossil Malacostracous Crustacea of Great Britain," Mon. Pal. Soc.: Part ii, 'Crustacea of the Gault and Greensand,' 1862, p. v) remarks:—"The Crustacea of the strata below the Chalk . . . . present several remarkable peculiarities in their forms and affinities. One of the most interesting of these is the existence of analogous or, so to speak, representative species in these beds and in the London Clay" (see part i of same Mon., 'Crustacea of the London Clay,' op. cit., 1857, pls. v and vi). "In some cases this representation is shown in their specific distinction, with the most perfect generic identity, as in the case of *Hoploparia*, of which we have already seen two very distinct species in the later formation, and we have now described no fewer than six species in the earlier deposits. In no instance do any of these locally separated individuals belong respectively to the same species; in every one the specific distinctness is unambiguous, but the generic relation to each other is no less so. Another case of nearly similar import occurs in the anomourous family Dromiadæ; the *Homolopsis* of the Greensand

[1] This line may be defined as the 'metabranchial furrow,' and is seen in *Plagiophthalmus oviformis* from the Greensand of Wilts, and in *Dromilites* from the London Clay.

being represented in the London Clay by two species of *Dromilites*, a very nearly allied form."

The addition of another new species, apparently related to this family in the Gault, is extremely interesting as exemplifying the close family similarity, but very clear specific and (I venture to think) in this case even generic distinctness from its congeners. It is hoped that before long other examples may be obtained, offering fuller details of its structure; meantime I publish this interesting little Crustacean, giving it the name of *Mesodromilites* to define its older geological position and also its probable relationship to *Dromilites* of the London Clay, with the specific name of *Birleyi*, in honour of Miss Caroline Birley, to whom I am indebted for the opportunity of describing this new Gault crab.

NOTICES OF MEMOIRS.

I.—The Red Colour of the Salt Lakes in the Wadi Natroun. By J. Dewitz.[1]

In an article published in the *Zoolog. Anzeiger*[2] I have given a report on the biology of the Natron Valley, the Wadi Natroun, in the Libyan desert, about 170 kilometers from Cairo. It seems that my remarks concerning the red colour of the water of the salt lakes of the valley have interested readers of the article. I therefore wish to add here some researches I was able to make on the same subject owing to the kindness of Mr. Prochaska, head of the chemical survey of the soda company.

When I came to the Natron Valley the red water of the lakes excited at once my curiosity, and I tried to ascertain the reason for the redness of the liquid. Most people to whom I spoke about the matter told me that *Artemia* lives in the lakes, and that the red colour of this Crustacean is communicated to the water. During my stay in the Wadi the *Artemia salina* was not to be seen, the animal appearing only at certain periods of the year. It is impossible to believe that the coloured mass of these small creatures is sufficient to stain such immense quantities of water as the Wadi Natroun lakes. These lakes, about fourteen in number, lie rather close to each other and extend over a space of about 40 kilometers.

No number of *Artemia salina* would be great enough to give the water the deep purple colour which it has. If there were frogs in the lakes and those frogs were red, and someone should say that the red colour of the water came from the red colour of the Amphibia, this explanation, I think, would not be much inferior to the *Artemia* theory. Besides *Artemia*, there are other red animals in the lakes. I obtained, for example, a red culicid larva. This shows that animals living in the water may take the colour from it, and not the water from the red animals. Finally, *Artemia salina* disappears in

[1] Reprinted from *Science*, N.S., vol. x (1899), No. 240, pp. 146, 147.

[2] "Das Wadi Natroun in der libyschen Wüste und seine niedern Thiere," Bd. xxii (1899), pp. 53–61.

the lakes for the greater part of the year without causing a change in the coloration of the water.

But, if it is not *Artemia salina*, what is it that gives the red colour to the water? In my investigations I treated the red water with different chemicals, among them acetic acid. When the acid is poured into the red water a powerful development of carbonic acid takes place, and at the same time a red soft mass rises to the surface of the liquid, while the latter loses more and more of its colour. From a large quantity of water I collected the soft red mass swimming on the surface, washed it with distilled water, and shook it in a mixture of ether and absolute alcohol. The red colour left the soft mass, being extracted by the ether. The solution of the colour in ether did not keep the purple tint of the soft mass, but showed a fine brownish coloration, the soft mass itself appearing now as a grey yellowish substance, reminding one of blood fibrine. It could be reduced to ashes, and is, therefore, of organic composition. When the lake water was directly exposed to the mixture of ether and alcohol without having passed through acetic acid no result was obtained. Concerning the osmotic property of the red organic mass, it is to be noted that it did not pass through a membrane of so-called parchment paper, such as is used for covering jars.

The experiments show that the water of the lakes contains an astonishingly great quantity of organic red substance, and that it is this which gives the red colour to the water.

The question now arises what the origin of the red organic substance is. My supposition is that the substance must be the product of bacteria. Each drop of water taken from the lakes will be found full of them. The bacteria in all the lakes are uncoloured, but I found that the cocci exhibit a red colour.

According to "Baedeker" (Egypt, French edition, 1898) there existed another spot in Egypt, near Suez, where red salt water is found. On p. 162 of the guidebook I read the following note: "La couleur rouge des marais salants entre des collines des Bédouins et le canal, provient d'une petite écrevisse (de l'ordre des phyllopodes) presque microscopique qui y fourmille à certains moments. Le matin ils exhalent un parfum semblable à celui des violettes." Unfortunately, when I was at Suez I did not visit the 'marais salants,' and I therefore wish to call this note to the attention of the biologists visiting that part of Egypt. It would be very interesting to ascertain whether the water there contains bacteria and the same red organic mass which I found in the lakes of the Natroun Valley.

II.—Notes on the Minerals of Japan. By Kotora Jimbō. (Reprint from Journ. Sci. Coll. Imp. Univ., Tōkyō, 1899, vol. xi, pp. 213–281.)

A DESCRIPTION is given of 128 mineral species found in Japan, and represented in the collections of Mr. T. Wada, of the Imperial University and the Imperial Museum at Tōkyō. The paper is written in English, and so renders information, which

previously has only been published in Japanese journals, more easily accessible. The subject-matter is mainly confined to the enumeration of occurrences; and for museum curators, puzzled by Japanese locality names, the paper will be very useful. Longer descriptions are given of quartz, topaz, and felspar, these minerals being represented in Japan by specially fine crystals.

REVIEWS.

I.—Dr. Traquair on Silurian Fishes. Report on Fossil Fishes collected by the Geological Survey of Scotland in the Silurian Rocks of the South of Scotland. By Ramsay H. Traquair, M.D., LL.D., F.R.S. Trans. Roy. Soc. Edinb., vol. xxxix, pp. 827–864, pls. i–v. (December, 1899.)

DR. TRAQUAIR'S new memoir on the Upper Silurian fishes of Southern Scotland is the most valuable contribution to our knowledge of Palæozoic Ichthyology which has been made for many years. It is of fundamental importance not only as describing with tolerable completeness the exoskeleton of several organisms which have hitherto been known only by indeterminable isolated fragments; it also records for the first time a series of well-ascertained facts in reference to the primitive mode of development of the dermal armour of the Vertebrata. Moreover, it is a work which could not have been accomplished, or at least have been done in a thoroughly trustworthy manner, by anyone less skilled in the observation and interpretation of Palæozoic fish remains than Dr. Traquair himself. Most of the fossils are very obscure, and can only be understood after long-continued study and repeated comparisons. Any geologist or biologist who casually examines them will feel gratitude to the painstaking author, whose patience and unwearied zeal have enabled him to obtain so much information from them as is contained in the beautiful memoir now before us.

The specimens in question were discovered by Messrs. Macconochie and Tait, collectors to the Geological Survey of Scotland, in the Upper Ludlow and Downtonian beds in the neighbourhood of Lesmahagow, Lanarkshire. The thin bands in which they occur consist of hard, grey, flaggy shale; and in most cases the actual substance of the fossils seems to be preserved.

The two first genera described are considered to be primitive Heterostraci or Pteraspidians, in which the dermal armour consists of isolated shagreen-like granules, not yet fused into plates. They constitute the family Cœlolepidæ of Pander, which was known only by the detached dermal granules until a year ago, when Dr. Traquair published a foretaste of his results in the description of *Thelodus Pagei* from the Lower Old Red Sandstone of Forfarshire. Two new species of *Thelodus* (*T. scoticus* and *T. planus*), from the Upper Silurian, are now described and figured. The head and trunk are completely covered with a dense layer of the little shining, quadrangular granules, which have long been familiar to

collectors from the Ludlow Bone-bed and the Upper Silurian of Oesel. In shape the fossilized organism closely resembles a *Cephalaspis*, and its anterior portion is usually crushed vertically, while its slender caudal region occurs in more or less direct side view. No orbits are distinguishable. There is no clear evidence

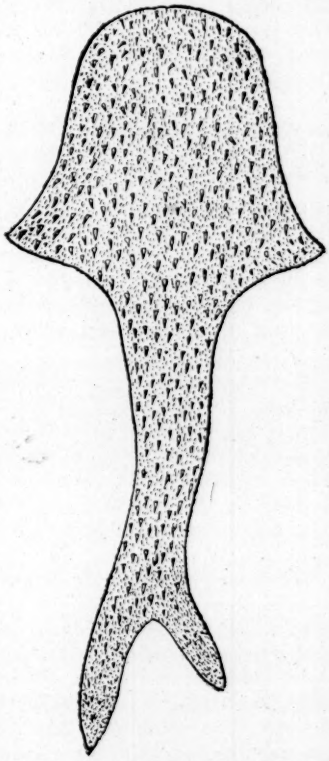


Fig. 1.—Restored outline of *Lanarkia spinosa*, Traq., in the position in which it occurs as a fossil, namely, vertically compressed in front, but the tail twisted round so as to appear in profile.

of paired fins. The heterocercal caudal fin is well preserved, but there is apparently no dorsal fin. *Lanarkia* is a new allied genus, armoured with small, sharp, hollow, conical spines, instead of the comparatively solid quadrangular tubercles. *L. horrida*, *L. spinulosa*, and *L. spinosa* (Fig. 1) are distinguished, the last with the dermal spinelets not uniform in size.

A remarkable new genus and species, *Ateleaspis tessellata*, follows next. The remains on which it is based are rather fragmentary; but Dr. Traquair is inclined to regard the organism as intermediate between the simplest Heterostraci and the Osteostraci, only referring it to the latter because part of the tissue of its armour exhibits true bone-cells. The general form of the body is apparently as in the Cœlolepidæ, but the dermal covering in front consists of small polygonal plates, while in the caudal region it is in the form of

flat, rhombic, sculptured scales. The orbits seem to have been close together on the top of the head, as in *Cephalaspis*.

A new order, Anaspida, is established to contain the two last and perhaps most extraordinary new genera treated in the memoir. These comprise small, laterally compressed organisms, without paired fins, but with a single small dorsal fin and a well-developed heterocercal tail. In many respects they are suggestive of *Cephalaspis* and its allies, but there is no continuous head-shield, and the orbits are not clearly distinguishable in the known specimens. The substance of the armour is not sufficiently well preserved to furnish satisfactory sections for microscopical examination. *Birkenia*, with a single species, *B. elegans*, is the first genus placed here. It is completely armoured with small scutes arranged in the strange manner indicated in Dr. Traquair's careful restoration (Fig. 2). On the side apparently of the back of the head there is an oblique series of eight small round holes, which look like branchial openings. The flank-scales of the trunk are disposed chiefly in series which incline forwards and downwards, not backwards and downwards as is usual in fishes. A median series of ventral scutes develops into a formidable armour of spines in the caudal region. The second new genus, *Lasanius*, with two species, *L. problematicus* (Fig. 3) and *L. armatus*, is considered to be closely related to *Birkenia*, differing in the loss of all the dermal armour except a few anterior flank-scales and the median ventral row of spines.

The detailed descriptions of these organisms are illustrated by a beautiful series of five plates, most of the drawings being by Mr. James Green, but the highly magnified details and critical points by the author himself.

In the concluding section of the memoir, which is a general discussion of the results, Dr. Traquair gives for comparison a brief description of the hitherto problematical Lower Devonian genus *Drepanaspis*. Its main features are illustrated in an outline-sketch which he kindly permits to be reproduced here (Fig. 4). In shape it resembles *Thelodus* and *Lanarkia*, but it is covered with well-developed plates and scales, and the orbits seem to have been placed laterally. All the known plates of *Drepanaspis* are too much pyritized for microscopical examination; but Dr. Traquair has shown that the other Devonian plates named *Psammosteus* belong to a closely similar animal, and these contain no bone-cells. The Drepanaspidæ and Psammosteidæ are therefore placed by him in the Heterostraci.

It follows from these researches that the definition of the order Heterostraci must now be slightly modified. We must admit that the armour may consist either of separate granules (each formed round a distinct papilla), or these granules may be more or less fused together in every degree from small polygonal plates to great shields. According to Dr. Traquair the order will therefore include the known families of Cœlolepidæ, Psammosteidæ, Drepanaspidæ, and Pteraspidæ, each exhibiting a progressive modification over the other in the development of the dermal armour.

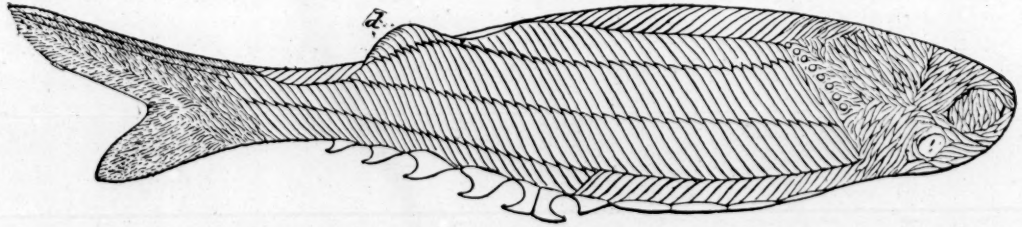


Fig. 2.—Restored outline of *Birkenia elegans*, Traq., one-half larger than natural size. *d.*, dorsal fin.

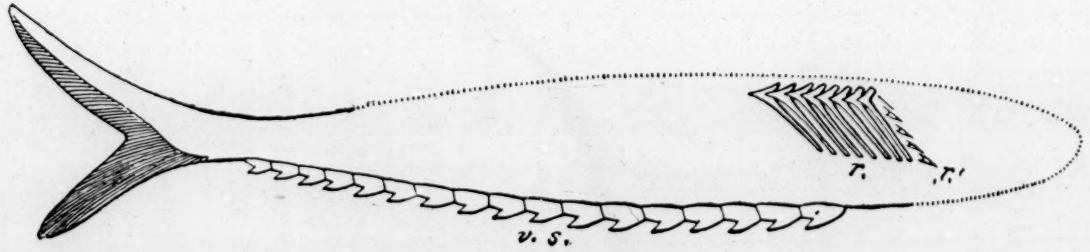


Fig. 3.—*Lasanius problematicus*, Traq., restored outline enlarged. *v.s.*, ventral scutes; *r.*, post-cephalic rods; *r'.*, chain of ossicles.

While the original conception of the Heterostraci is enlarged in this manner, *Ateleaspis* seems to form a link between its lowest family (the Cœlolepidæ) and the order Osteostraci. Dr. Traquair points out that the shape of this organism is like that of *Thelodus*, while its polygonal plates and scales merely represent groups of the dermal tubercles of the latter fused together by the great development of their bases. At the same time some of the basal layers of

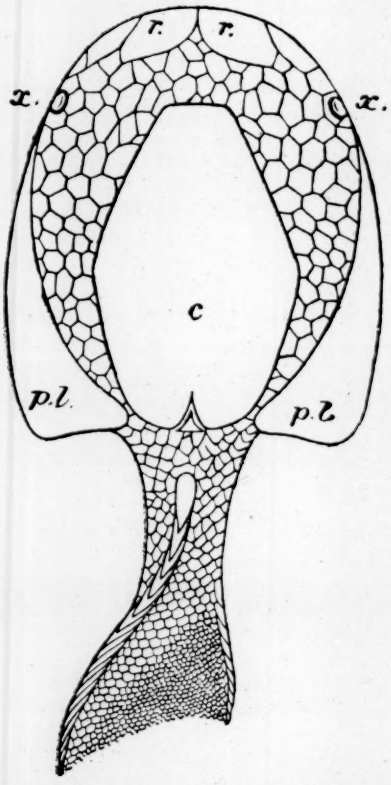


FIG. 4.—*Drepanaspis Gmuendenensis*, Schlüter. Restored outline of the dorsal aspect, the surface ornament omitted, and the tail twisted round so as to show the caudal fin in profile. *c.*, central plate; *p.l.*, postero-lateral plates; *r.*, rostral plates; *x.*, orbits?

the plates contain distinct bone-cells, a peculiarity necessitating the reference of *Ateleaspis* to the Osteostraci. Dr. Traquair is therefore of opinion that Cope and the British Museum Catalogue are correct in regarding the Heterostraci and Osteostraci as closely related orders, while Professor Lankester is no longer justified in maintaining that "there is absolutely no reason" for grouping them together beyond that they "occur in the same rocks."

As might be anticipated, Dr. Traquair also discusses the propriety of admitting the existence of the sub-class Ostracodermi, to which the Heterostraci and Osteostraci have been referred by Cope and the British Museum Catalogue. He concludes that no more satisfactory arrangement can be suggested at present. He accordingly accepts it, and adds the new order Anaspida to include the Birkeniidæ.

The most disappointing feature of the memoir is, that it provides no new facts which will be universally regarded as advancing our knowledge of the affinities of the Ostracodermi. Dr. Traquair is very emphatic in his refusal to believe that they are "Agnatha." Very justifiably, he declares that he has no faith in negative evidence. He must have some positive reason before he can admit that these organisms were destitute of a mandibular arch and paired limbs. On the other hand, he thinks his new discoveries justify a belief that the Ostracodermi are the modified descendants of an early group of Elasmobranchii. He "prefers to consider" the Cœlolepidæ, or lowest Ostracoderms, "as having definitely split off from the [Elasmobranchii], from which they doubtless originally came" (p. 844).

When, however, the arguments for this new interpretation are closely examined, I maintain that they are found to depend just as much on negative evidence as the hypothesis of Cope. So far as I understand them, they are based on two propositions — (i) that the shagreen of the Cœlolepidæ is identical with that of an Elasmobranch, and (ii) that the lappet-like postero-lateral angles of the anterior broad part of the body in the Cœlolepidæ, Drepanaspidæ, and Cephalaspidæ are pectoral fins.

As to the first proposition, I think there is justification for asserting that, in the present state of knowledge, it affords no sure proof of affinity between the Ostracoderms and the Elasmobranchs. We cannot conceive of the dermis of a chordate animal beginning to acquire superficial calcified hard parts by any other process than by the deposition of mineral matter round papillæ. At the remote period when the Chordata were first beginning to develop an exoskeleton, it is extremely probable that these animals were already well differentiated; at least, we cannot explain their diversity and high grade in the early Devonian period unless we admit this probability. When dealing with Silurian fish-like organisms, therefore, a form armoured with tubercles of dentine does not necessarily belong to the Elasmobranchii; it may be a Chordate animal of any kind just beginning to assume a protective covering. The admitted fact that since early Carboniferous times an exoskeleton exclusively of dentinal tissues has persisted only in Elasmobranchii and Chimæroidei, is no proof that any organism similarly armoured in the strange archaic Devonian and Silurian faunas is intimately related to either of these sub-classes.

In short, if Dr. Traquair has discovered that the Cœlolepidæ are closely related to the Heterostraci proper and to the Osteostraci, as seems almost certain, I maintain that he has not helped us towards forming any more plausible theory of their origin. He has merely

dealt another blow at the old Agassizian conception of the importance of dermal structures in classification. He has shown that 'placoid scales' are as of little value for taxonomic purposes in the Silurian and Devonian periods as are 'ganoid scales' in the Tertiary and existing faunas.

Dr. Traquair's second proposition that the Cœlolepidæ and Drepanaspidæ possess pectoral fins, seems to me to be much more absolutely an hypothesis than my contrary assertion that *Cephalaspis* is destitute of them. So far as I understand, not a single specimen of *Thelodus* or *Lanarkia* shows the slightest change in texture or arrangement of its armour at the postero-lateral angles of the broad part of the organism, which are described as lappet-like pectoral fins. There is no more appearance of flexibility here than along any other border. There are not the faintest lines of demarcation of any kind. In the remarkable genus *Drepanaspis* the angles in question are indeed strong plates, apparently without any power of motion. Nevertheless, Dr. Traquair still considers them as pectoral fins, believing them to be "rendered utterly functionless as fins by being enclosed in unyielding bony plates." In other words, a motile organ, originally used at least for balancing, if not for progression, is assumed to have lost its function, not by atrophy, but by conversion into a rigid structure continuous with its base of support—a phenomenon for which I have tried in vain to find a parallel in the animal kingdom. Personally, I consider it is less hypothetical to believe that the postero-lateral angles in question are not homologous with the flaps in *Cephalaspis*, but with the hinder end of the branchial chamber of the same. Both hypotheses depend on negative evidence, but I prefer the latter as most reasonable.

With respect to the flexible flap in *Cephalaspis*, which I regard as opercular, but which Dr. Traquair now thinks is really a pectoral fin, I may repeat that we know exactly its relationships. The specimens in the British Museum show that it is a flexible outgrowth from the hinder margin of the roof (perhaps more accurately the outer and partly upper wall) of the branchial chamber, while the external outlet of this chamber is clearly a large oval opening immediately beneath (within) the base of the flap.

In conclusion, I therefore believe that Dr. Traquair's hypothesis of the derivation of the Ostracodermi from an early race of Elasmobranchs with a mandibular arch and paired fins, depends quite as much on negative evidence as does Cope's theory that they are far more primitive and best termed Agnatha. I still maintain that they "are quite of a problematical character"; but of the two theories proposed for their interpretation, I think that of Cope is, for the present, the less beset with difficulties.

A. Smith Woodward.

II. — Geschichte der Geologie und Paläontologie bis Ende des 19 Jahrhunderts. Von Karl Alfred von Zittel. (R. Oldenbourg: München u. Leipzig, 1899.)

History of Geology and Palæontology up to the end of the Nineteenth Century. By Karl Alfred von Zittel. Demy 8vo; pp. vii and 868.

THIS volume forms one of a series of histories of science in Germany in recent times, issued, under the patronage of the King of Bavaria, by the Royal Academy of Sciences at Munich. Its preparation had at first been entrusted to the late Professor Ewald of Berlin, but it remained unfinished at the time of his death, and, in accordance with the terms of his will, the incomplete MS., with his other papers, was destroyed. The task was then undertaken by Professor von Zittel, and the contents of this volume prove that it could not have been allotted to abler hands. The work was intended originally to be limited to a history of geology in Germany only, but the author enlarged the plan so that it should include a history of the science generally, and present a faithful picture of the successive stages in its development wherever they may have occurred. Whilst it may be true that the German literature on the subject has been, in some parts, referred to with greater fulness than that from other countries, no important contribution from other sources has been overlooked, and the author's comments and criticisms on the writings and achievements of past and present geologists are marked by the strictest judicial impartiality. With respect to subjects which are still matters of controversy, the author takes a neutral position, and contents himself with a plain statement of facts and opinions relating to the particular questions in dispute.

The History is treated under four periods of very inequal length and interest: 1st, the geological knowledge of the ancients; 2nd, the early stages of palæontology and geology; 3rd, the heroic age of geology, from 1790 to 1820; and 4th, the later development of geology and palæontology.

With respect to the first period, that of the geological knowledge of the ancients, the author shows that whilst facts relating to the science were of a limited character, hypotheses on the origin and development of the earth were plentiful enough. If any of these latter have perchance been found conformable to modern views, it is due to their being lucky speculations rather than theories based on observation. At the same time, some of the observations made at this period on earthquakes, volcanoes, changes of level of the earth's surface, and on the action of water, are not without importance.

Neither does the second period, which includes from about 800 A.D. to the close of Buffon's career in 1788, present us with any solid or striking advance in geological science. We find that fossils aroused the attention and curiosity of many of the learned in different parts of Europe during the fifteenth to the seventeenth centuries, and many were figured with remarkable fidelity in the works of Lister, Lang, and Knorr and Walch; but their real characters were

unrecognized and they were attributed to a certain 'vis plastica,' and considered to have been directly produced in the ground where they were met with. Even when they were seen to be the remains of extinct animals, they were supposed to have reached their position in the rocks through the action of Noah's Deluge! The palæontology of this period did not advance beyond dry, detailed descriptions of fossils, with fantastic speculations as to their origin, and their relation to the sacred scriptures.

Amongst the writers of this period whose observations of geological facts and whose views of the origin and history of the earth are placed before us by the author, we find the names of Leonardo da Vinci, Giordano Bruno, Nicholas Steno, Burnet, John Woodward, Scheuchzer, John Ray, Charpentier, and Guettard; whilst amongst those distinguished for their observations on volcanoes and earthquakes occur the names of Della Torre, Desmarest, Sir W. Hamilton, and Faujas de St. Fond.

In the concluding part of the chapter on this period a summary of the views of Buffon on the theory of the earth is given, with an appreciative reference to the position which this great French philosopher occupies in geological history. As an original investigator and observer his claims were limited, but he understood the significance of facts, and possessed a marvellous capacity of marshalling them in support of his theories. He was incontestably the most genial representative of that speculative movement, held in high repute in the sixteenth, seventeenth, and eighteenth centuries, which set itself to solve its problems in a deductive way. With Buffon there closed a period which had indeed gathered together a large store of materials needful for the earth's history, and had moreover arrived at the conviction that the data for that history might be obtained from the earth itself. But the key for the determination of a chronological succession of events on our planet had not as yet been discovered, no satisfactory insight as to the composition and building up of the earth's crust had been obtained, nor of a regular succession of the fossil remains found within it.

With the third period of the heroic age of geology, placed by the author in the thirty years from 1790 to 1820, there commences an epoch when facts were recognized and sought after as the only sure foundation for theory, and a corresponding appreciation was placed on the investigation and description of the phenomena of the earth's crust which are within the limits of human observation. Amongst the imposing host of geologists of this period whose works are passed under review occur the names of Werner, Pallas, Saussure, Hutton, Playfair, William Smith, Leopold von Buch, Alexander von Humboldt, Alex. Brongniart, and Cuvier. Perhaps the most conspicuous amongst his contemporaries is the celebrated Freiberg Professor, A. G. Werner, of whose teachings and of the wonderful influence which he exercised on his students a very graphic account is given by the author. It is difficult to realize at the present day that the teaching of Werner that all the rocks of the earth's crust

had been produced as chemical or mechanical deposits from a watery solution should have been so firmly maintained and strenuously defended, and that it was only overthrown after a lengthened period of violent controversy.

But whilst Werner, with a renown akin to that of a prophet, had drawn to himself a school of ardent disciples from all civilized countries, a simple teacher in Scotland, James Hutton, was preparing his work on "The Theory of the Earth," which was destined to exercise a powerful influence on modern geology long after the Neptunist theory of Werner had exploded. The great merit of Hutton, as the author points out, is that he based his conclusions on inductions from previously observed facts, and explained the phenomena by the action of forces still in operation, so that he had no need to call in the aid of supernatural or imaginary powers. As is well known, many of Hutton's ideas were more fully expanded by subsequent authors, notably by Sir Charles Lyell, and thereby the credit justly due to him has, in a measure, been attributed to others.

To the genius of another of our countrymen of this epoch, William Smith, is due the discovery of the leading principle that the succession of the rocks may be known by their included fossils. A sympathetic account of William Smith's work is given by the author, with an able summary of his character in the following terms:—"William Smith was self-educated, a man of rare originality and unusual penetration. Without academic training, without any guidance, without any material support, and at the beginning without even encouragement from his contemporaries, he succeeded by his tenacious perseverance in tracing out the geological structure of England in so clear a manner that subsequent investigation has not made any important change in the groundwork he laid down. Smith limited himself to the practical study of the geology of his native land, and abstained from all general speculations on the origin and history of the earth. On his work, thus wisely limited, rests his greatness, and to it this modest, unselfish, and open-hearted observer owes the well-deserved appellation of Father of English Geology."

The position occupied by geology in the principal countries of Europe during this heroic period, and the lines of investigation followed by the leaders of the science in each, are passed under review: the various textbooks on geology and geognosy published in this interval are noticed as contrasting favourably by their sober, practical treatment of the subject with the more speculative works of the preceding epoch, and sketches are given of the advances made in the study of petrology and palæontology. Owing to the great influence of Werner's teaching, which did not take much account of fossils, their study did not take so high a position during this period as that of petrology. The great French anatomist, Cuvier, however, dwelt much on the importance of fossil organisms in the study of the earth's history in general, and of organic life specially. In the warm eulogium pronounced on him by Von Zittel it is pointed out

that his merit chiefly rests on his achievements in vertebrate palæontology, in establishing a scientific method in the nomenclature of fossil osteology, and in the convincing proof which he gave that fossil mammals belonged to extinct genera and species and that they could not be regarded as mere varieties of forms now living. At the same time he maintained the unchangeableness of species, and denied that there was any genetic connection between the earlier forms of organic life and the present ones. It must be confessed that on some points he stood at a lower level of knowledge than his contemporaries, and that some of his theoretical conclusions tended to hinder rather than forward the advance of geology.

The author's fourth period — the more recent development of geology and palæontology, from 1820 to the present time—is treated at great length, and occupies about three-fourths of the volume. After the close of the last epoch, which might well be termed the spring-time of the science, geology entered on a new phase. Its position as not the least important of the natural sciences had been established, and in most of the great centres of academical learning courses of study were founded and collections of rocks and fossils made for teaching its principles. The period for great discoveries had passed; hasty and superficial observations and wide generalizations were replaced by deeper and more detailed investigation, less brilliant perhaps, but more permanent in its results. The list of eminent professors and teachers of geology in the Universities of Germany during this recent period indicates the high importance attached to the science in that country, in a measure greater than that shown in the corresponding institutions in England and in France.

The value of geology in many departments of practical life, such as mining, agriculture, building, etc., was not long hidden from Government authorities, and led to the establishment of official Geological Surveys for the purpose of investigating and mapping the geological structure of their respective countries. The first to be founded was that of the Geological Survey of the United Kingdom in 1835, and since then Government Surveys with a similar object have been formed in nearly every State in the civilized world. A further notable impulse to the study of geology in recent times has been derived from the societies and associations for the encouragement of independent researches in the science which have sprung up in different countries.

The wide field for observation presented by the diverse aspects of geology in its later developments, and the vast store of materials collected from so many varied sources, naturally led to a division of labour amongst the workers, and hence the science became divided up into a series of special departments, more or less intimately linked to each other and to the sister sciences, though often differing materially from each other in their mode of working. It was therefore impossible to treat the recent development of geology as a whole, and the author has consequently given us a history of the origin, the growth, and the present position of each of the separate branches of

the science, which are referred to in as many chapters under the headings of Cosmical, Physiographical, Dynamical, and Topographical Geology, Stratigraphy, and Petrography. It would be beyond our province to refer to the numerous points of importance in each of these subjects, which have been so thoroughly and lucidly stated by the author; their intimate connection with the present generation of geologists will cause them to be scanned with the liveliest interest.

In the concluding chapter, Palæontology, the science with which Von Zittel's name will ever be associated, is treated in a somewhat condensed form, and consists chiefly of short references to the principal groups of fossil organisms and to the authors and works in which they have been described. It would almost seem as if the author's vast knowledge of the subject had restrained him from venturing into details which might have proved overwhelming.

We cannot finish this short notice without expressing our high opinion of the value of this work to all geologists and to others interested in the science of geology who desire to be acquainted with its early history and the various stages it has passed through in the course of its growth up to the present time. The author is heartily to be congratulated on having successfully carried out this arduous undertaking, the character of which can only be appreciated by those who have some knowledge of the enormous literature which has to be studied and digested for its preparation.

III.—Indian Geology.

1. Memoirs of the Geological Survey of India, vol. xxv: Geology of Bellary District, Madras Presidency. By R. Bruce Foote, F.G.S., F.M.U. Superintendent, Geological Survey of India. 8vo; pp. xviii and 218 (1895), with a folding geologically coloured map of the Bellary District (October, 1896). (Calcutta, 1897.)
2. The Geology of Baroda State. By R. Bruce Foote, F.G.S., C.F.E.G.S., Geological Survey of India (retired), and lately State Geologist, Baroda. Published by order of H.H. the Gaekwar. 8vo; pp. x and 194, with 3 folding maps (1897–98). Received December, 1899. (Madras, 1898.)

THE author of these memoirs is one of the oldest and most experienced members of the Geological Survey of India, and although he has retired some time from the staff, he has remained resident in India.[1] He has just sent us a copy of his memoir on the Geology of the Bellary District in the Madras Presidency, being the last piece of his official survey work, done some time since. The map which accompanies this memoir is a good specimen of modern chromolithography, well and clearly printed in colours, which define alluvium, laterite-breccia, the Dharwar System and hæmatites, the granitoids and gneisses, the steatite beds, granite veins, trap-dykes, crystalline limestones, etc.

[1] Undertaking the Geology of Baroda and of Mysore States for their respective native Governments.

Bellary District lies between Haidarabad on the north, Mysore on the west and south, and Anantapur on the east. It forms the western division of the Ceded Districts (so-called because ceded by the Nizam by treaty in 1800 to the East India Company); it lies in the centre of the Deccan tableland, and has an area of 5,904 square miles. Nearly the whole area has a general slope to the northward, and is drained by the Tungabhadra River. Thirty-one hills are cited by the author having altitudes varying from 1,674 feet to 3,285 feet.

The rocks of the district are arranged in four principal groups—

	IV. Recent and Post-Tertiary.	*Subaerial.* — Talus formation. Cemented Taluses. Pseudo-Lateritic Breccias. Kankar formations. Blown sands. Regur. Red soils. Mixed and white soils.
		Alluvial.—Modern Alluvial deposits (loams and shingle beds) of the Tungabhadra and its tributaries. Fossiliferous Travertine. Consolidated shingles. High-level gravels (old alluvium) of the Tungabhadra. Shingle fans.
	III. Tertiary (?).	*Terrace Laterite.*
	II. Lower Transition.	*Dharwar System.*—Principal metalliferous rocks of South India.
Azoic.	I. Archæan or Metamorphic and Plutonic.	Granitoids and gneisses with associated traps, etc.

The Archæan rocks, which form the fundamental series in the peninsula, are very largely developed in the Bellary District, and occupy fully five-sixths of its area. Their extent alone, therefore, renders them the most important geological series to be treated of; they are deserving of much interest, and of far closer study than could be bestowed upon them, because of their general poverty in minerals of economic importance, to the quest for which much more time had to be devoted.

Taking the district as a whole, it must be described as consisting mainly of granitoid rocks, generally of porphyritic character, the metamorphic or gneissic crystallines playing a very subordinate part in most places, though of such great importance in other parts of the Madras Presidency.

The description of the Archæan or metamorphic rocks occupies the whole of chapter iv, pp. 26–73.

"Very marked and interesting illustrations of the power of weather-action along lines of jointing are to be seen on the top of the Fort Hill in the shape of water-holes which have been utilized as cisterns. In every case the weathering has worked along lines of jointing and produced the remarkable holes which are so useful in holding rain-water, and of which the native builders availed themselves so fully by increasing the water-holding capacity by dams.

"Some people seem to think the constant supply of water in these holes a rather mysterious phenomenon, whereas it is in reality a very simple one. The several catchment-areas which supply the holes are more than large enough to fill them in good rainy seasons, and the larger holes are so deep that their stock of water cannot evaporate more than partially before they get a fresh supply from the skies, and

thus they never run dry in a normal succession of seasons. There is, then, no need to appeal to occult causes, such as natural *artesian action, pressure derived from the copper-mountain,* or *subterranean syphons connected with mysterious water stores at unknown depths,* goodness knows where!" (p. 58.)

The lower Transition or Dharwar Rocks, a great system of sub-metamorphic sedimentary rocks with numerous contemporaneous trap-flows, was first recognized by Foote as distinct from the South Indian gneiss; these rocks were originally deposited over very much larger areas than those they now occupy, and very probably extended across the whole or nearly the whole peninsula.

The Dharwar System was exposed to great contortion and deformation at a very remote geological period, followed by vast denudation, which eroded and cut up the enormous folds, into which they had been previously forced, into the great bands in which they now occur. These transition rocks are richly interbedded with bands of hæmatite, giving them great stability and resistance to denudation, so that they now form most of the hilly country of the district. Many illustrations and geological sections accompany this chapter, pp. 74–175. These are followed by the intrusive rocks in the Archæan area, the Laterite terraces, the alluvial deposits, the subaerial formations, and economic geology. Under this last heading we find that iron, manganese, gold, and copper are met with, the iron alone occurring in any quantity. There are also excellent building stones.

The last chapter is devoted to prehistoric economic geology, and describes the various implements met with of Palæolithic and Neolithic age down to iron axes closely imitating polished stone implements in form.

2. *Baroda State.* — Mr. Bruce Foote introduces his memoir on Baroda as follows:—"The duty of making a geological survey of the Baroda State was entrusted to me early in October, 1891, and occupied the working seasons of 1892, 1893, and 1894. During those three years I visited carefully and examined closely all the important mineral regions lying within the limits of the State, both in Gujarat and Kathiawar. The completion of this memoir has been delayed partly by personal ill-health and by difficulties connected with the preparation of the maps and plates requisite to illustrate the memoir, the work required being of such a nature that all the most important parts had to be done by myself, and did not admit of my being appreciably assisted by anyone else."

The Gujarat divisions of Baroda are separated from each other by intercalated parts of British territory belonging to the districts of Surat, Broach, Kaira, and Ahmedabad, and the political agencies of Rewakanta, Panch Mahals, and Mahikanta.

The southern half of the Baroda territory lies about ten miles inland from the Gulf of Cambay, except in the Nausari taluq between Mindhola and Purna Rivers, where the Baroda territory forms the seaboard; but the State possesses no seaport of any

value, while, owing to the silting up of the estuaries of the great rivers, no craft of any size can ascend to any point within the State boundaries.

The northern half of the State lies entirely inland along the valleys of Mahi, Sábarmati, and Sarasvati Rivers.

The drainage of the Gujarat divisions of Baroda State all falls westward into the Arabian Sea, and, excepting that of the most northerly taluqs, which are drained by the Banass and Saraswati Rivers into the Runn of Kach, falls into the Gulf of Cambay, which receives such a vast amount of silt brought down by the larger rivers that it is rapidly being silted up, as shown by the present condition of the harbours of Surat, Broach, and Cambay. Not two centuries ago the seaports were visited by fleets of shipping of the ordinary size of the traders of those days. Now they are with difficulty reached by vessels of as low a tonnage as about 30 tons.

The succession of the rocks met with in the Gujarat divisions of Baroda State are referable to the following groups, which are here arranged in descending order :—

VI. *Recent* (b) *Subaerial Formations.*—Blown sands; soils; the great blown loam or 'Loess' formation; fluviatile and marine alluvia.

(a) *Old Alluvia of the Great Rivers.*—Consolidated grits and ferruginous gravels of the Sábarmati, Mahi, and Tapti Quaternary deposits.

V. *The Eocene* (*Nummulitic*) *System.*—Clays, cement-stones, limestones, conglomerates, and laterites of the Kim and Tapti Valleys. Laterites and sandstones of the Sábarmati Valley. Laterites of Purna and Ambika Valleys.

IV. *The Deccan Trap* (*Cretaceous*) *and Intertrappean Rocks.*—Traps and intertrappean rocks of the Mohar Valley (Atarsumba). Traps and intertrappean rocks of the Mahi Valley (Sauli taluq). Intertrappean rocks in the Vishwamitri. Traps in the Dev River. Traps in the valley of the Heran. Spurs of the Rajpipla Hills north of the Tapti. Spurs of the Sahyadri range south of the Tapti. Dykes traversing the southern trap area.

III. *The Bagh Series.*—Songir conglomerates and sandstones in Sankheda taluq, and conglomerates and limestones in Sauli taluq.

II. *The Champanir System.*—Quartzites forming the hills north of the Orsang River. Quartzites, limestones, calcareous schists, clay schists, and slates in the valley of Heran and Aswan Rivers.

I. *The Archæan Rocks.*—Granite with pegmatite veins of the Upper Sábarmati Valleys. Granites, gneisses, and crystalline limestones of the Orsang and Unch Valleys, Sankheda taluq. Intrusive rocks, pegmatites, quartz reefs, and trap-dykes.

Although so much of the country is masked by deep coverings of alluvium, of sand, loess, and other late deposits, the Eocene (Nummulitic) System, where it occurs, yields some fossils which

have been identified by Stoliczka as—*Rostellaria Prestwichi*; *Terebellum*; *Cerithium*; *Cypræa elegans*; *Natica longispira*; *Conus*, sp.; *Trochus*, sp.; *Pholas*, sp.; *Pecten Hopkinsi*; *P. Favrei*; *P. corneus*; *Vulsella legumen*; *Ostrea Flemingii*; *O. lingura*, etc.; *Nummulites perforata*; *N. Brongniarti*; *N. exponens*; and *N. spira*.

Under the head of Economic Geology, the author points to one serious drawback to the development of the country, namely, the want of roads. Owing to the want of construction these lines of would-be traffic are during the rains totally impassable, districts are entirely isolated from one another, and travelling becomes impossible. In dry weather the mud is exchanged for deep ruts and suffocating clouds of dust. The tanga frequently sinks up to the axle-tree. Iron and iron-ores are fairly abundant; gold also is met with, but in very small quantity. Building material can be obtained readily within a reasonable depth below the surface in the western taluqs of the Kari and Baroda Prauts.

Part II is devoted to a sketch of the geology of the Gaekwari Districts in the Kathiawar Peninsula. This area is about 1,320 square miles in extent, and largely occupied by rolling plains, which as a rule are treeless and cheerless in aspect. The Gir forest is hilly, and is the last refuge of the Gujarat lion, now reduced to about forty individuals.

The succession of the rocks in the Kathiawar Gaekwari is limited to—

III. Recent.	}	Alluvium and subaerial deposits.
	}	Miliolite.
II. Tertiary.	}	Dwarka beds.
	}	Gaj beds.
I. Cretaceous.		Deccan Trap Series.

The only economic product of importance here seems to be the building stones, principally the miliolite or Porbander stone largely quarried at Porbandar.

It is quite impossible to do justice as we could desire to this valuable memoir in the space at our command. Three large folding maps greatly assist the comprehension of the regions described.

Everyone interested in Indian geology will be grateful to Mr. Bruce Foote for his contributions to a fuller knowledge of these districts, which he has so carefully examined and reported upon. Wherever Mr. Bruce Foote goes he gathers not only geological notes but also ethnological treasures. One of these, which he figures in this volume (pl. v), is a rude Palæolithic axe from the alluvium of the Sábarmati River, and is very remarkable in shape, not unlike an iron adze in form.

IV.—General Report on the Work carried on by the Geological Survey of India for the period from April 1, 1898, to March 31, 1899. Under the direction of C. L. Griesbach, C.I.E., F.G.S. Large 12mo; pp. 91. (Calcutta, 1899.)

AMONG the various materials of this Report there is much interest to be found in the "Lists of Assays and Examinations made in the Laboratory during the past year" (pp. 3–10), including the

account of a Stony Meteorite (p. 2) which fell at Gambat in Sind, September 15th, 1897. Dr. A. von Kraaft reports on the Spiti fossils (pp. 11–22), collected by Mr. H. H. Hayden, whose report on the geology of Spiti is given at pp. 46–50. Economic inquiries by the Surveyors, beginning with the distribution of mica and the local systems of mining, were made under the superintendence of Mr. T. H. Holland, whose much extended issue of the late Professor Val. Ball's account of Indian Corundum, Ruby, and Sapphire, from Part iii of the "Manual of the Geology of India," 1881, was published in 1898. A preliminary report is given at pp. 28–33. Mr. La Touche's discovery of a coal area in Bikanir is reported (pp. 33–35) as being likely to prove very valuable. Another landslip at Naini Tal is reported at p. 35. Geological Surveys have been carried on in the Central Provinces, Central India, Western Rajputana, Himalayas, and Baluchistan, with good results, often of much interest. A list of additions to the Library is appended as usual. T. R. J.

V. — The Palæontographical Society of London: Annual Volume (LIII) for 1899. Issued December, 1899.

THE volume issued by the Society for the year 1899 contains portions of four monographs; two of these are devoted to the bivalved Mollusca, which, by the way, in one monograph are called Lamellibranchia and in the other Lamellibranchiata.

1. A Monograph of the British Palæozoic Phyllopoda (Phyllocarida), Packard. By Professor T. Rupert Jones, F.R.S., F.G.S., etc., and Dr. Henry Woodward, F.R.S., F.G.S., etc. Part IV (Conclusion): General Title-page; pp. i–xv, 175, 176 (reprinted), 177–211; pls. xxvi–xxxi.

This forms the concluding portion of this Monograph, the preceding parts of which appeared in the volumes of the Palæontographical Society for the years 1887, 1892, and 1898. The study of the genus *Dithyrocaris*, which was commenced in part iii, is continued and concluded. Two new species, *D. Dunnii* and *D. Neilsoni*, are described from tail-pieces; the former upon specimens found by Mr. John Dunn in the Redesdale Shales, Northumberland, the latter upon examples in Mr. Neilson's collection from East Kilbride. A new genus, *Chænocaris*, is proposed to include McCoy's *Dithyrocaris tenuistriatus* from the Carboniferous Limestone of Little Island, Cork, and a new species (*C. Youngii*) founded upon a specimen from the Upper Limestone group of the Lower Carboniferous series at Robroyston, Lanarkshire. For the unique specimen in the Museum of the Geological Survey of Scotland that was collected from a "'greenish-grey' (now reddish), flaggy, calcareous shale of the Lower Red Sandstone series at the Carmichael Burn, near the Manse, four and a half miles south-east of Lanark," and previously described as *Dithyrocaris striatus*, the new genus *Calyptocaris* is proposed, and into it is placed, somewhat doubtfully, a new species (*C.? Richteriana*) founded upon a single specimen from the "Cypridinen-Schiefer" (Entomis-shales), at Saalfeld, Sachsen-Meiningen.

Then follow descriptions of various tail-pieces belonging to the genus *Dithyrocaris*; some remarks upon the allied genus *Mesothyra* from the Devonian strata of North America, and a note upon F. A. Roemer's *Dithyrocaris Jaschei* from the Hercynian Limestone in the Klosterholz, near Ilsenberg, Hartz, which the authors refer with a query to the genus *Ptychocaris*. There is a short chapter on "The Gastric Teeth of *Dithyrocaris*," with a number of illustrations of these curious little fossils. The part concludes with observations on "Some Allies of *Dithyrocaris*." These are—(i) *Lebescontia ænigmatica*, a new genus and species founded upon two specimens which were collected by M. Paul Lebesconte, of Rennes, from the Lower Silurian rocks of Brittany and neighbourhood, which, although "somewhat obscure on account of imperfection, distortion, and embedment," the authors believe to be "the relics of some kind of bivalved or shield-like Phyllopod, near to but not identical with *Dithyrocaris*"; (ii) *Lebescontia occulta*, a new form from the "Upper Limestone" series at Linn Spout, south-west of Dalry, twenty miles south-west of Glasgow; (iii) *Hibbertia orbicularis*, already described and figured by the authors in the Geological Magazine for September, 1899.

This being the concluding part of the Monograph there are various lists, several pages of "Addenda et Corrigenda," and an index and general title-page to the whole volume. The binder is instructed to "*cancel* the title-pages of parts i, ii, iii, and iv . . . and *substitute* the general title-page given in the volume for the year 1899"; but though the dates of the several parts are given, some workers may prefer to have the volume bound with the title-pages of the several parts in position as issued. We shall certainly do so ourselves.

2. A Monograph of the Cretaceous Lamellibranchia of England. By Henry Woods, M.A., St. John's College, Cambridge. Part I: Nuculanidæ, Nuculidæ, Anomiidæ, and Arcidæ. pp. 1–72; pls. i–xiv.

Mr. Woods has already devoted much attention to the Palæontology of the Invertebrata, and not very long ago contributed to the Geological Society of London an important paper on "The Mollusca of the Chalk Rock" (Q.J.G.S., vol. lii, 1896, pp. 68–98, pls. ii–iv; and ibid., vol. liii, 1897, pp. 377–404, pls. xxvii and xxviii). Mr. Woods doubtless found the nomenclature of the Cretaceous Lamellibranchiata in a sad state of confusion, and this may have led him to commence the present Monograph. The bad state of preservation of many of the Chalk Mollusca renders their study exceedingly difficult; but as the Chalk is now attracting the special attention of not a few geologists, it is very desirable that all the Mollusca, especially the Lamellibranchiata and the Gasteropoda, which have hitherto been in a very unsatisfactory state, should be overhauled, and the nomenclature corrected as far as possible. Mr. Woods' monograph appears, therefore, very opportunely, and he deserves the hearty thanks of all for undertaking to work out this very difficult group. As in every other group, many species have been very differently interpreted by different authors; we are therefore glad to find that whenever possible the type-specimens of the species

have been examined, for very often this is the only way to arrive at a satisfactory conclusion.

This first part of Mr. Woods' Monograph deals with the Nuculanidæ, the Nuculidæ, the Anomiidæ, and the Arcidæ. The arrangement of the species of each genus is in the main stratigraphical.

The Cretaceous members of the family Nuculanidæ are comprised in the genus *Nuculana*, H. F. Link, and range from the Crackers and Atherfield Clay of Atherfield, through the Gault and Upper Greensand, possibly into the Chalk Rock. It is found also at several horizons in the Speeton Clay, a new form, *N. Speetonensis*, being described from the Speeton Clay of Speeton, upon specimens in the British Museum (Natural History) and in the Museum of Practical Geology, but their precise horizon is not recorded.

The only representative of the family Nuculidæ is the genus *Nucula*, Lamarck, which occurs in the Speeton Clay, and ranges from the Lower Greensand through the Gault and Upper Greensand, possibly into the Chalk Rock. A new species (*N. Lamplughi*), the types of which are in Mr. Lamplugh's collection, is described from the Speeton Clay (D 4) of Speeton.

The Cretaceous Anomiidæ are comprised in the genus *Anomia*, Linnæus, which ranges from the Lower Greensand through the Gault, Upper Greensand, and Cambridge Greensand, into the Totternhoe Stone.

The family Arcidæ is represented by the genera *Arca*, Linnæus (*sensu stricto*); *Barbatia*, J. E. Gray; *Grammatodon*, Meek & Hayden; *Trigonoarca*, T. A. Conrad; *Cucullæa*, Lamarck, with the new subgenus *Dicranodonta*; *Isoarca*, G. Münster; *Pectunculus*, Lamarck; and *Limopsis*, A. Sasso. The subgenus *Dicranodonta* is proposed for W. Keeping's *Cucullæa Donningtonensis*, the types of which came from the Claxby Ironstone, Benniworth Haven, and are preserved in the Woodwardian Museum, Cambridge; but the species is also recorded from the Lower Greensand of Upware. The author places with a query in this same subgenus the species which W. Keeping described as *Pectunculus obliquus* from the Lower Greensand of Upware; and he considers that the form described by Keyserling and by Schmidt as *Pectunculus Petschoræ* probably also belongs here. A new species of *Pectunculus* (*P. euglyphus*) is founded upon three specimens in Mr. Meÿer's collection from the Chalk Marl (Meÿer's bed ii) of Dunscombe, and a new species of *Limopsis* (*L. albiensis*) upon some specimens from the Lower Gault (zones ii, iii, and vii) of Folkestone, that are preserved in the Museum of Practical Geology, Jermyn Street.

3. A Monograph of the British Carboniferous Lamellibranchiata. By Wheelton Hind, M.D., etc. Part IV: Edmondidæ, Cyprinidæ, Crassitellidæ. pp. 277–360; pls. xxvi–xxxix.

In the present part the author deals with the rest of the Edmondidæ, comprising, in addition to those treated of in part iii, the genera *Sedgwickia*, M'Coy; and *Edmondia*, De Koninck, with the subgenus *Scaldia*, De Ryckholt. *Sedgwickia* is represented by five

species, three of which (*S. ovata*, *S. Scotica*, and *S. suborbicularis*) are described as new. In his observations on this genus the author states that "*Venus centralis*, M'Coy, and *Dolabra securiformis*, M'Coy . . . doubtless belong to the genus; unfortunately, however, the type specimen of the former has decomposed, and that name can no longer be retained." If we are to conclude from this statement that when the type-specimen decomposes the name of the species disappears, what a prospect for the names of the Gault and London Clay fossils, which have such a strong inclination to go 'wrong'! The genus *Edmondia*, De Koninck, is represented by about twenty species, six of which are regarded as new, and the subgenus *Scaldia*, De Ryckholt, by two species.

Of the Cyprinidæ the author recognizes among the Carboniferous Lamellibranchiata only the new genus *Mytilomorpha*, the typical Carboniferous form of which he considers to be that described by Phillips as *Cypricardia rhombea*; the only other British Carboniferous species being *M. angulata*, n.sp.

To the Crassitellidæ Dr. Hind refers Hall's genus *Cypricardella*, seven species of which are described in the present part; Fischer and Beushausen placed this genus in the Astartidæ, and the author admits that it really possesses characters intermediate between the two "genera" [families]. He regards *Astartella* and *Cypricardella* as probably identical, and says (p. 347) "the date of the description of *Astartella* is 1858, the same year as that of *Cypricardella*," a statement, however, which does not quite agree with the references to these two genera given on the preceding page.

4. A Monograph on the Inferior Oolite Ammonites of the British Islands. By S. S. Buckman, F.G.S., etc. Part XI. Supplement: ii.—Revision of, and addition to, the Hildoceratidæ. pp. xxxiii–lxiv; pls. v–xiv.

Mr. Buckman continues his revision of this family, dealing chiefly with the forms which were referred in the body of the work to *Lioceras* and *Ludwigia*. He says that "nearly all the specimens inscribed as *Lioceras* in the body of this work must be removed from that position." The genus *Lioceras* is restricted, *opalinus* being the type species of the genus, and "Quenstedt's fig. 10 in pl. vii of his 'Cephalopoden' is regarded as the arbiter of what is *opalinus*." Several new species and not a few new genera are proposed.

VI.—A Treatise on Crystallography.—By W. J. Lewis. pp. 612, with 553 figures in the text. (Cambridge, 1899.)

DURING Mr. Lewis's tenure of the University Professorship, which has extended over nearly twenty years, the subject of Mineralogy (in combination with Crystallography) has been made an independent subject of the Natural Sciences Tripos, and for some time has had a considerable number of students; a textbook of Crystallography at once suited to the requirements of the Tripos and corresponding in its methods and terminology to the professorial lectures will be a great boon to Cambridge men, and the book will doubtless be welcomed in other Universities, both at home and

abroad, more especially in America. Among the many good points which we have noticed, we may more particularly mention the lucid descriptions of the methods of crystal drawing and the numerous worked problems illustrating in detail the methods practically adopted in the calculation of the forms of crystals from the measured angles. The methods of projection and the uses of anharmonic ratios are also well explained. In the treatment of the subject great stress is laid on the independence of the thirty-two types of crystalline symmetry, and their deduction and characteristics are illustrated in full detail. Most of the figures have been specially drawn, and there are frequent references to the specimens preserved in the Cambridge Collection. The Cambridge University Press is to be heartily congratulated on this particularly handsome and valuable addition to its series of Natural Science Manuals.

M. F.

VII.—First Appendix to the Sixth Edition of Dana's System of Mineralogy. By Edward S. Dana. pp. 75. (New York, 1899.)

THE usefulness of the well-known Dana's System of Mineralogy, the sixth edition of which was published in 1892, has been increased by the issue of a First Appendix, which includes within a brief compass a description of the more salient characters of the new mineral species discovered during the last seven years, and an account of the results of later research on the species already described in the Sixth Edition itself. For convenience the mineral species are noted in alphabetical order, and full references are given to the original memoirs. The Appendix is brought well up to date, and takes account of researches published very shortly before its own appearance.

M. F.

VIII.—The Geology of the South Wales Coalfield. Part I: The Country around Newport, Monmouthshire. By Aubrey Strahan, M.A., F.G.S. Memoirs of the Geological Survey. pp. vi, 97. (London: printed for H.M. Stationery Office, 1899. Price 2*s*.)

THE resurvey of the great Coalfield of South Wales was commenced in 1891 by Mr. Strahan, and has been carried on with the aid of Mr. J. R. Dakyns (who has now retired from the service), Mr. R. H. Tiddeman, Mr. Walcot Gibson, and Mr. T. C. Cantrill. The present Memoir is the first of a series intended to explain the one-inch geological maps of the district, of which four have now been published. In it we have descriptions of the Silurian rocks of Usk, of the Old Red Sandstone, Carboniferous rocks, Keuper Marl, Rhætic Beds, Lower Lias, Glacial Drifts, and more recent deposits. The Silurian rocks comprise Wenlock and Ludlow Beds, and while they are overlain with apparent conformity by the Old Red Sandstone, it is noted that the plane of demarcation is sharp and that there is no evidence of gradation. This is not as we have usually been taught to believe. Moreover, instead of any break in the Old Red Sandstone, marking a division into Upper and Lower beds, it is

stated that the entire group is made up of a conformable series of red sandstones, conglomerates, and marls with cornstones. Of these, three divisions have been traced out and coloured on the map. Remains of *Pteraspis* and *Cephalaspis* occur in the lowermost division.

The Lower Carboniferous rocks rest conformably on the Old Red Sandstone, but they differ from equivalent beds in the Mendip area, inasmuch as the mass of "Lower Limestone Shales" there, is represented in the neighbourhood of Newport by a lower bed of brown, often oolitic, encrinital limestone 50 to 100 feet thick, surmounted by from 40 to 90 feet of shale. Above is the main mass of Carboniferous Limestone, which in the area now described varies from 150 to 700 feet. No particular attention appears to have been given to the fossils of these rocks, and we can hardly wonder that this has been the case. Fossils are not readily to be obtained from the Carboniferous Limestone of Monmouthshire, and the field-geologist can scarcely give the weeks of labour to quarries and other exposures of rock, without which collecting would be of little value.

No distinct division of "Upper Limestone Shales" is recognized. The strata immediately above the Carboniferous Limestone are grouped as Millstone Grit, and they comprise not only the characteristic hard grit with quartz pebbles, but considerable masses of shales. The details relating to the Coal-measures naturally form the most important features in this Memoir, judged from an economic point of view. A study of the various faults and dislocations is most important, and these will be best understood when the map is placed alongside the memoir. Descriptions are given of the Keuper Marls, the Rhætic Beds, and the Lower Lias which are exposed near Newport, in quarries and cuttings at Lis-Werry and at Goldcliff on the Severn shore. Various Glacial drifts, River gravels, and other Alluvial deposits are also described.

IX.—Preliminary Notice of the Etcheminian Fauna of Cape Breton. By G. F. Matthew, LL.D., etc. Bull. Nat. Hist. Soc. New Brunswick, vol. iv, pp. 198–208, pls. i–iv. December, 1899.

THE fossils described in this article were collected from a terrane beneath the Cambrian in Cape Breton Island, in the province of Nova Scotia, Canada. The sections given prove that this terrane is beneath the Cambrian, which overlies it unconformably. They show no 'Lower Cambrian,' as the faunas of *Paradoxides* and *Protolenus* are absent, or, at least, have not been recognized. The beds are therefore assigned by Dr. Matthew to the same level as the beds of similar appearance and position in New Brunswick and Newfoundland (see Geological Magazine, Dec. IV, Vol. VI, pp. 373 and 472, August and October, 1899; see also next notice). The Pre-Cambrian life-period thus revealed has been named Etcheminian by its discoverer. It was a period characterized in this region by much volcanic activity, and by rather humble forms of life: worms in abundance, primitive brachiopods, Capulidæ but few other molluscs, some ostracods but no trilobites. None the less, still a long way from the beginning of things.

The fauna in the Cape Breton Etcheminian is quite different from

that found in rocks supposed to be of the same age in Newfoundland; in fact, the genera are all such as occur at the base of the Cambrian in New Brunswick (*Protolenus* zone). A difference of age, however, is to be inferred from the fact that the species are all different and new. Of Brachiopods there are—*Lingulella*, two species; *Leptobolus* (?), two sp.; *Obolus* (subgen. *Palæobolus*, n.subgen.), one sp.; *Acrothele*, one sp.; *Acrotreta*, one sp. Of Ostracods there are—*Bradoria* (n.gen.), three sp.; *Schmidtella*, two sp. Four plates of figures representing these species accompany the article.

X.—Studies on Cambrian Faunas: No. 3, Upper Cambrian Fauna of Mount Stephen, etc.; No. 4, Fragments of the Cambrian Faunas of Newfoundland. Also The Etcheminian Fauna of Smith Sound, Newfoundland. By G. F. Matthew, D.Sc., LL.D. Trans. Roy. Soc. Canada, ser. II, vol. v (1899), sect. 4, p. 39.

THESE articles on the early Palæozoic faunas of the eastern part of Canada and Newfoundland and on that of Mount Stephen in British Columbia serve to extend and broaden our knowledge of the species of that early time in America. Dr. Matthew, on a careful review of the Mount Stephen fauna, concludes that it may be regarded as equivalent to the *Peltura* fauna of N.W. Europe. Eleven genera of trilobites are recognized,—*Ogygia* (*Ogygopsis*), *Bathyuriscus*, *Zacanthoides*, *Neolenus* (n.gen. with 5 n.spp.), *Ptychoparia*, *Dorypyge*, *Agnostus*, *Corynexochus*, *Dolichometopus*, *Oryctocephalus*, and *Conocephalites*. Two new genera and four new species of Hyolithidæ are described. This problematic group of animals is, in accordance with the views of Pelseneer and Holm, absolutely removed from the Pteropoda or any other Mollusca, and is referred by Dr. Matthew to the Annelida, a conclusion which is at any rate more consistent with their predominance at so low a geological horizon.

Under 'Study' No. 4, a variety of forms from several horizons of the Cambrian of Newfoundland is described. *Raphistoma* (?) *Kelliensis*, n.sp., is an early type of a Pleurotomarioid Gasteropod. Several worm-burrows and trails are described, and a large *Hyolithes*. Among the trilobites is a *Microdiscus*; the Agrauloid forms are represented by *Strenuella* (subgen.); two new species of *Miomacea* are described; one new *Avalonia*, and a fine *Metadoxides*. The Conocoryphinæ are re-classified, *C. trilineatus* as subgen. *Atops*, and *Erinnys venulosa*, Salt., as *E.* (*Harpides*) *breviceps*, Ang.

The third article gives the fauna of a set of beds described by the author as a separate terrane, lying beneath the beds that carry the well-known fauna of *Paradoxides* and the less-known fauna of *Protolenus*, which underlies it. This fauna, to which we have referred in the preceding note, is remarkable for the prevalence of Hyolithidæ and primitive types of Gasteropods and Brachiopods. In this article the new Gasteropod genus *Randomia* is described, and the following new species: *Kutorgina*, one sp.; *Randomia*, one sp.; *Platyceras*, three sp.; *Modiolopsis*, one sp.; *Urotheca*, one sp.; *Helenia*, one sp.; *Hyolithellus*, one sp.; *Orthotheca*, four sp.; *Hyolithes*, one sp.; *Aptychopsis*, one sp.

The articles are accompanied by eight plates of figures.

REPORTS AND PROCEEDINGS.

Geological Society of London.

December 20, 1899.—W. Whitaker, B.A., F.R.S., President, in the Chair. The following communications were read:—

1. "On some Effects of Earth-movement on the Carboniferous Volcanic Rocks of the Isle of Man." By G. W. Lamplugh, Esq., F.G.S., of H.M. Geological Survey.

[Communicated by permission of the Director-General of the Geological Survey.]

The author, since the completion of his survey of the Isle of Man, has studied the coast-section in the Carboniferous Volcanic Series between Castleton Bay and Poolvash, with the result that he has discovered evidence that the strata have undergone much deformation in pre-Triassic times, and probably before the Upper Permian rocks of the island were deposited. In the western part of the outcrop the volcanic material consists almost wholly of tuff, in places bedded and fossiliferous; in the eastern part there exists a chaotic mass of coarse and fine fragmental volcanic material traversed by ridges of basaltic rock and containing entangled patches of dark limestone. The author now considers that the larger lenticles and most of the smaller blocks of limestone have been torn up from the underlying limestone floor during a sliding forward or overthrusting of the volcanic series upon it. Such blocks do not contain ashy material, and the patches of truly interbedded, ashy limestone can be distinguished from them. The sections at Scarlet Point, Poolvash, and between Cromwell's Walk and Close ny Chollagh Point are described and figured. Strips of limestone are found to shoot steeply upwards and become wedged in between the blocks in the agglomerate; they give indications of sliding and disturbance, and their outer surfaces are indurated and chert-like. The ash, which usually rests on black argillaceous limestone flags, in places appears to come into juxtaposition with a somewhat lower horizon, crushed, platy material intervening between the two. Steep domes of the limestone break into sharp crests which shoot up into the ash and are bent over towards the north; and between the crests there are small ragged strips of limestone entangled among the tuff. Bands of vesicular basalt are bent and shattered. A dyke-like mass has had a segment sliced off and thrust forward among the agglomerate, so that its flow-lines of vesicles are sharply truncated along the fractured edge, which is often notched and filled in with ash as though lumps had been torn out of it. The composition of the included masses is influenced by the neighbourhood of the rocks *in sitû*, calcareous near limestone, basaltic near the basalt masses.

The phenomena may be explained as the result of earth-movement on a group of rocks consisting of limestone passing up into tuff, interbedded with lava-flows, and possibly traversed by sills or dykes of basaltic rock. The effects of the disturbance appear to be limited vertically and horizontally, and to have been influenced by the differential resistance of the component rocks. Analogous features occur in the Borrowdale Volcanic Series and in the Silurian volcanic rocks of Portraine.

2. "The Zonal Classification of the Wenlock Shales of the Welsh Borderland." By Miss Gertrude L. Elles. (Communicated by J. E. Marr, Esq., M.A., F.R.S., F.G.S.)

This paper deals with the Wenlock Rocks of Builth, the Long Mountain, and the Dee Valley, and establishes the following sequence in these districts:—

Builth.	Long Mountain.	Dee Valley.		Southern Sweden.
Lower Ludlow.	Lower Ludlow.	Moel Ferna Slates.	Nant-Glyn Flags.	*Cardiola*-Shales.
6. Zone of *Cyrtograptus Lundgreni*, Tullb.	Zone of *C. Lundgreni.*		Slates with very few graptolites.	Zone of *C. Carruthersi*, Lapw. = Zone of *M. testis.*
5. Zone of *Cyrtograptus rigidus*, Tullb.	Zone of *C. rigidus.*		—	Zone of *C. rigidus.*
4. Zone of *Cyrtograptus Linnarssoni*, Lapw.	Zone of *C. Linnarssoni.*		Zone of *C. Linnarssoni.*	
3. Zone of *Cyrtograptus*, sp. nov.	?	Pen-y-glog Grit.		Zone of *M. Riccartonensis*
2. Zone of *Monograptus Riccartonensis*, Lapw.	Zone of *M. Riccartonensis*	Pen-y-glog Slates.	Zone of *M. Riccartonensis.*	
1. Zone of *Cyrtograptus Murchisoni*, Carr.	?		Zone of *C. Murchisoni.*	Zone of *C. Murchisoni.*
(Local Unconformity.) Tarannon Shales? Llandovery Grits.	(Local Unconformity.) Purple Shales (? Tarannon). Llandovery Grits.	(Succession conformable.) Tarannon Shales. Corwen Grit.		(Succession conformable.) Shales with graptolites.

The results obtained by the author completely confirm the work of Tullberg on the Wenlock Shales of Southern Sweden.

Along the Welsh border the Wenlock Rocks do not cover a large area, but are merely a fringe to the Ludlow Rocks. The former are characterized by graptolites of the *priodon-Flemingii* type, the latter by those of the *colonus* type.

The general structure of the Builth district is a syncline towards the north and north-west part of a series of folds whose axes run north-east and south-west. A later set of movements, along east and west axes, and of later date, lifted the district to the north and north-west of Builth, and, combined with the effect of previous movements and subsequent denudation, caused the exposure in the

north and north-west of beds which are overlapped to the east. The full six zones in the foregoing table occur to the north-east of Builth Road Station, but some of them are overlapped north-west of Builth; and at Aberedw Hill, east of Builth, only the highest zone is exposed. The entire succession in the north and north-west part of the district is given below :—

Ludlow.	10. Hard light-grey siliceous flags.		
	9. Micaceous sandy shales, with rotten limestone bands.		
Wenlock Shales.	8. Calcareous flagstones, with fossiliferous bands.		
	(*f*) 7. Calcareous fissile shales, with beds of flagstone. = Zone of *Cyrtograptus Lundgreni*.		
	(*e*) 6. Hard grey calcareous shales with graptolites. = Zone of *Cyrtograptus rigidus*.		
	5. Light-coloured flags, unfossiliferous	(400 feet) ?	
	(*d*) 4. Grey calcareous flags and shales, with limestone concretions	300 feet.	
	= Zone of *Cyrtograptus Linnarssoni*.		
	(*c*) 3. Soft shales with harder flaggy beds	200 feet.	
	= Zone of *Cyrtograptus*, sp. nov.		
	(*b*) 2. Hard calcareous flagstones	300 feet.	
	= Zone of *Monograptus Riccartonensis*.		
	(*a*) 1. Soft fissile shales alternating with flags. = Zone of *Cyrtograptus Murchisoni*.		

The Wenlock Shale of this area was deposited on the sinking shore-line of the old Llandeilo ridge, resulting in the overlap of higher beds on lower.

The Long Mountain is a syncline with north-east and south-west axis. Here also there must have been deposition on a sinking ridge accompanied by overlap. The lowest beds, exposed near Chirbury, belong to the zone of *Monograptus Riccartonensis*; but on the north-west side, near Middletown, the lowest beds seen above the Tarannon shales belong to the zone of *Cyrtograptus Linnarssoni*. The relationship of these beds to the Tarannon shales is regarded as an unconformability. The sections in this district confirm those established for the Builth area.

In the Llangollen Basin the general structure is a synclinal fold complicated by many minor folds and faults. The 'pale slates' are covered by darker shales belonging to the zone of *Cyrtograptus Murchisoni*; and in this district the relationship of the lowest zones is clearer than at Builth or the Long Mountain.

The palæontological part of the paper describes several species, some of which are recorded for the first time in the country: *Cyrtograptus Carruthersi*, *C. rigidus*, and a new species of *Cyrtograptus* of zonal value, four varieties of *Monograptus Flemingii*, three of *M. vomerinus*, one variety of *M. testis*, and two new species of *Monograptus* are amongst the forms dealt with.

3. "On an Intrusion of Diabase into Permo-Carboniferous Rocks at Frederick Henry Bay (Tasmania)." By T. Stephens, Esq., M.A., F.G.S.

The relationship of the abundant diabase to the Permo-Carboniferous strata of the island has been long a matter of dispute. Among others, Jukes described sections which appeared to confirm the view that Permo-Carboniferous sediments were deposited round

vast masses of igneous rock previously cooled and denuded. The author has identified and visited the sections, and finds in one that, although there is a step-like junction between the sediments and the igneous rocks, it is the result of intrusion of diabase, and not of the deposition of sediment. The sediment, which is fossiliferous, is converted into an intensely hard whitish marble, and the associated shale bands into chert. The diabase, which is ordinarily an ophitic rock, acquires at the junction a finely crystalline-granular structure. Jukes's second section also gives undoubted evidence of intrusion.

GEOLOGICAL SOCIETY OF LONDON: MEDALS AND AWARDS, January 10th, 1900.

The Council of this Society has decided to give the Medals and Awards on February 16th, 1900, as follows:—

The "Wollaston Gold Medal" to the American Geologist, Professor G. K. Gilbert, For. Memb. Geol. Soc., of the United States Geological Survey, Washington, D.C., U.S.A.

The "Murchison Medal" to Baron Adolf Erik Nordenskiöld, Ph.D., For. Memb. Geol. Soc., of Stockholm.

The "Lyell Medal" to Mr. J. E. Marr, M.A., F.R.S., F.G.S., of Cambridge (for many years Secretary of the Geological Society of London), Fellow of St. John's College, Cambridge.

The Wollaston Fund to Mr. George Thurland Prior, M.A., F.G.S., of the Mineralogical Department, British Museum (Natural History), S.W.

The Murchison Fund to Mr. A. Vaughan Jennings, F.L.S., F.G.S., Assoc. R.S.M., etc.

The Lyell Fund to Miss G. L. Elles, Woodwardian Museum, Cambridge.

The Barlow-Jameson Fund (1) to Mr. G. C. Crick, Assoc. R.S.M., F.G.S., Geological Department, British Museum (Natural History), Cromwell Road, S.W.; (2) to Professor T. T. Groom, M.A., D.Sc. Lond., F.G.S., of the College, Reading.

CORRESPONDENCE.

THE COLOUR OF GLASLYN AND OF LLYN LLYDAW.

SIR,—Glaslyn and Llydaw are the names of the two chief Snowdonian lakes. Glaslyn has from time immemorial been noted, as its name implies, for the greenish colour of its water; but until this year, 1899, there has not been anything peculiar about the colour of Llydaw. Last summer, however, for the first time within at least the last fifty years, the water of Llydaw has become as green as that of Glaslyn. The cause of this change of colour is not far to seek, for last spring the company that works the Snowdon copper-mine commenced crushing and washing their ore on the bank of Llydaw, so that a large quantity of greenish débris is daily carried into the lake, whose water has thus become turbid and greenish in colour. The rock excavated along the copper veins is of a greenish hue, as anyone may see by looking at the tips at the mouths of the

adit levels. The change of colour in Llydaw explains the colour of Glaslyn, about the cause of which there has hitherto been some doubt, for it must now be obvious that Glaslyn owes its green colour to the detritus of green rock washed into t from the adit levels of the mine.

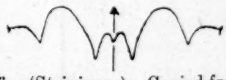
J. R. Dakyns.

Pen-y-Gwryd, *Nov.* 14, 1899.

CATALOGUE OF THE FOSSIL CEPHALOPODA IN THE BRITISH MUSEUM (NATURAL HISTORY), PART III: A CORRECTION.

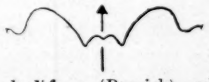
Sir,—The woodblocks used in illustrating Part iii of the "Catalogue of the Fossil Cephalopoda in the British Museum (Natural History)," by Dr. A. H. Foord and myself, have just passed through my hands, and on comparing them with the figures in the book I find that there has been a very unfortunate transposition of the figures of the suture-lines of some of the species of *Gephyroceras*. The blocks themselves are numbered correctly, but owing to a printer's error they do not appear in their proper places in the volume. The following corrections are necessary:—For Fig. 33 (suture-line of *Gephyroceras affine*) see Fig. 34; for Fig. 34 (suture-line of *Gephyroceras calculiforme*) see Fig. 36; for Fig. 35 (suture-line of *Gephyroceras æquabile*) see Fig. 33; and for Fig. 36 (suture-line of *Gephyroceras serratum*) see Fig. 35. These four figures, then, with their descriptions, should have been as follows:—

Fig. 33.



Suture-line of *Gephyroceras affine* (Steininger). Copied from Holzapfel and completed.

Fig. 34.

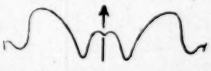


Suture-line of *Gephyroceras calculiforme* (Beyrich), enlarged. After Sandberger.

Fig. 35.

Suture-line of *Gephyroceras æquabile* (Beyrich). After Sandberger.

Fig. 36.



Suture-line of *Gephyroceras serratum* (Steininger). After Sandberger.

Geo. C. Crick.

British Museum (Natural History).
December 22, 1899.

THE SUB-OCEANIC VALLEY OF THE RIVER CONGO.

SIR, — I have just completed the details of this magnificent submerged river-channel by means of the soundings on the Admiralty chart No. 604. Fortunately they are sufficiently numerous at this part of the African coast to enable me to do so with great accuracy. That the Congo valley is continued under the Atlantic to a great depth has been known for some years, and accompanying the paper by Mr. Edward Stallibrass on "Deep-sea Soundings in connection with Submarine Telegraphy,"[1] there is a plan of this sub-oceanic valley from the mouth of the Congo down to the 1,000-fathom contour, which very closely corresponds with that drawn by myself. The scale of Mr. Stallibrass' map is about half that of the Admiralty chart, or about 25 miles to the inch: the details deserve publication on the full scale. The length of the submerged valley is about 120 miles, and, like those of the West of Europe, it opens out on the abyssal floor at a depth of 1,200 fathoms. The valley is remarkably straight for a distance of about 100 miles, and nearly coincides with the 6th parallel of South latitude, but at this point bends slightly northwards. It is generally narrow, and bounded by walls, in some places precipitous, descending to depths of 2,000–4,000 feet within very short horizontal spaces, and the average fall of the channel is 60 feet per mile. It is unnecessary to point out the significance of the presence of this great submerged river valley as far south as 6° beyond the Equator. It proves beyond question that the western margin of Africa has shared in the great upheaval and subsequent depression by several thousand feet of that of Western Europe and the British Isles, and, let me add, represents on the eastern side of the Atlantic the uprise and depression of the Antillean continent so ably elucidated by Professor Spencer. I hope to treat this subject more fully in a paper to be read before the Victoria Institute this session. EDWARD HULL.

January 15, 1900.

OBITUARY.

JOHN RUSKIN, M.A., LL.D., D.C.L., F.G.S.

BORN FEBRUARY, 1819. DIED JANUARY 20, 1900.

THE great Art-writer and Critic of the century, John Ruskin, passed away peacefully on the afternoon of Saturday, 20th January, his life's work accomplished long since.

Few men have had greater influence on modern thought in matters pertaining to art, pictures, sculpture, and architecture than John Ruskin; he was always an idealist and romantically enthusiastic in his notions, and wholly unworldly, yet no one believed more strongly than he did in his ability to regenerate the world and reform its abuses. His kindness of heart was extreme, and his sympathies were universal. He has been, as such a man naturally would be, severely criticized for his published views on 'Political Economy,'

[1] Journ. Telegraphic Engineers, vol. xvi (1888), p. 479.

and his fierce comments on those manufacturers and merchants who pile up riches by the employment of labour. Doubtless Ruskin forgot for the moment that his own splendid abilities mainly owed the opportunity for their development and sustained energy through life to the accumulated fortune of his father, a partner in the firm of Ruskin, Telford, & Domecq, London.

His success as an art-critic and writer gave him unbounded belief in his power to carry out any matter upon which he had set his heart. Thus, at one time (resenting the intervention of publishers) he determined to print, illustrate, and publish his own works. At another time he started a business as a tea-dealer in order to show that trade might be conducted in an honourable and honest manner. He encouraged the undergraduates at Oxford to dig and repair the roads; and he himself undertook to keep the streets clean between the British Museum and St. Giles', engaging a staff of helpers and setting them an example of their duties.

Everyone who loves Ruskin is, of course, well acquainted with his numerous works—his "Modern Painters," "Stones of Venice," "Seven Lamps of Architecture," "Lectures on Architecture and Painting," "Fors Clavigera," "Ethics of the Dust," "Sesame and Lilies," and some thirty other works, essays and lectures. But how many are aware that he had a strong attachment to geology and mineralogy!

When taken as a boy to Wales by his parents he enjoyed his first sight of really bold scenery; he ascended Snowdon and Cader Idris, and, to his intense delight, found for the first time in his life a real mineral. Ruskin believed if he had been allowed to remain there in charge of the good Welsh guide and his wife they would have made a man of him, and also "probably the first geologist of my time in Europe." Although this youthful dream was never realized, and he devoted his after years to art and architecture, his crossings and recrossings of the Alps in his frequent pilgrimages to his beloved Italy made a powerful impression upon his imagination, as may be seen by his notes and sketches published in the Geological Magazine for 1865, whilst his subsequent papers on Banded and Brecciated Agates, 1867–1870, op. cit., may still be read with intense pleasure for their wonderful word-painting; these, too, being *all illustrated by Ruskin's own hand.* His "Deucalion" on Geology is also most attractive.

Only a few years since he was deeply engrossed in arranging a case of specimens in the Mineralogical Gallery of the British Museum of Natural History, Cromwell Road, to illustrate the structure of Agates, accompanied by a printed description by himself. To this collection he also presented the great South African uncut natural gem, which he named the "Colenso Diamond" after the late Bishop Colenso. The Ruskin Museum, founded by him at Meersbrook Hall, near Sheffield, is a treasure-house of Art, in which minerals also find a place. Of Ruskin's many acts of noble generosity to the world the public Press is now everywhere speaking in most just and appreciative praise; the innumerable kindnesses which he secretly performed will never be known, but they will serve to keep his

memory green in the hearts of a large circle, to whom, although occupying quite humble positions, he had endeared himself for all time by calling them *his friends.*

TITLES OF PROF. RUSKIN'S PAPERS PRINTED IN THE GEOLOGICAL MAGAZINE.

1. "Notes on the Shape and Structure of some parts of the Alps, with reference to Denudation." Vol. II (1865), pp. 49–54 and 193–196, Pl. VI and Woodcuts.
2. "On Banded and Brecciated Concretions." Vol. IV (1867), pp. 337–339, Pl. XV.
3. "On Brecciated Formations." Vol. IV (1867), pp. 481, 482, Pl. XX.
4. "On Brecciated Concretions." Vol. V (1868), pp. 12–18, Pl. III and Woodcuts; pp. 159–161, Pl. X; and pp. 208–213, Pl. XIII and Woodcuts.
5. "On Brecciated Concretions." Vol. VI (1869), pp. 529–534, Pl. XIX and Woodcuts.
6. "On Banded and Brecciated Concretions." Vol. VII (1870), pp. 10–14, Pl. II and Woodcuts.

MISCELLANEOUS.

PRESENTATION OF A TESTIMONIAL TO THE REV. PROFESSOR WILTSHIRE, M.A., D.Sc., F.L.S., F.G.S., ETC., Honorary Secretary of the Ray and Palæontographical Societies.—A well-attended meeting of the members of the Palæontographical and Ray Societies was held at the Geological Society's Apartments, Burlington House, on Tuesday, December 19; the Rt. Hon. Sir John Lubbock, Bart.,[1] P.C., M.P., D.C.L., LL.D., F.R.S., President of the Ray Society, in the chair, supported by Dr. Henry Woodward, F.R.S., F.G.S., President of the Palæontographical Society. The object of the joint meeting was to present to the Rev. Prof. Wiltshire, the Hon. Secretary of both the above-named Societies, his portrait in oils, an illuminated address, and a cheque for £138—the balance of the sum subscribed after defraying expenses—in recognition of the services rendered by him to these Societies and to Palæontology and Zoology during a period of more than thirty years. The portrait was executed by Miss Atkinson, the illuminated address by Miss G. M. Woodward. Among those present were—The Right Rev. Bishop Mitchinson, Master of Pembroke, Oxford; Professor T. McKenny Hughes, F.R.S., and Professor W. J. Lewis, of Cambridge; the Rev. R. A. Bullen, the Rev. G. F. Whidborne, V.P. Pal. Soc., the Rev. H. H. Winwood, Dr. W. T. Blanford, F.R.S., Mr. John Hopkinson, Professor T. Rupert Jones, F.R.S., Sir Owen Roberts, Dr. D. H. Scott, F.R.S., Mr. F. W. Rudler, F.G.S., and Mr. A. Strahan; many ladies were also present. The presentation address was delivered by Sir John Lubbock, and the Rev. Professor Wiltshire responded. Speeches were also made by Dr. Woodward, Professor T. McKenny Hughes, Rev. G. F. Whidborne, and the Rev. H. H. Winwood; 132 subscribers took part in the testimonial.

CORRIGENDA.—In Mr. F. Chapman's paper on *Patellina*-limestone, which appeared in our last issue, the following corrections should be made: pp. 11, 12, and 17, for *Patellina Egyptiensis* read *Patellina Ægyptiensis*; pp. 13 and 17, for *Polytrema papyracea* read *Polytrema papyraceum.* — Also on p. 40, line 20 from foot, for "Applied Geology," read "Applied Geography."

[1] Now "Lord Avebury."